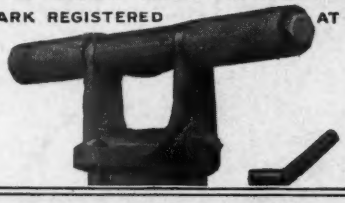
GENERAL LIBRARY
Engineering Library
MAR 81 1
UNIV OF MI

COMPRESSED AIR MAGAZINE

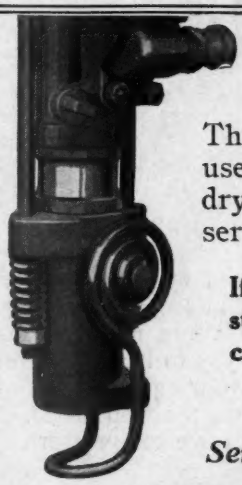
DEVOTED TO THE USEFUL APPLICATIONS OF COMPRESSED AIR

Vol. xxiv MARCH, 1919 No. 3

"JACKHAMER"
TRADE MARK REGISTERED AT OFFICE



THE NAME OF A SUPERIOR ROCK DRILL SERVICE



A few everyday pursuits to which the **"Jackhamer"** is peculiarly adapted.

Mining
Quarrying
Construction
Bridge Building
Municipal Improvements
Farming
Reclamation
Caisson Work

The **"Jackhamer"** can be used for drilling wet or dry holes, light or heavy service, hand or mounted.

If it can be drilled with steel the "Jackhamer" can drill it.

Send for bulletin 4321

INGERSOLL-RAND COMPANY

11 BROADWAY NEW YORK — **Offices the World Over** — **165 Q. VICTORIA ST LONDON**

176-JD

OVER 15,000 COPIES THIS ISSUE

Published by THE COMPRESSED AIR MAGAZINE CO., Easton, Pa.

NEW YORK, Bowling Green Building LONDON, 165 Queen Victoria Street

Classified Buyers' Guide, Page 14. Index to Advertisers, Page 16.

The STEARNS-ROGER Mfg. Co.

OF DENVER, COLORADO

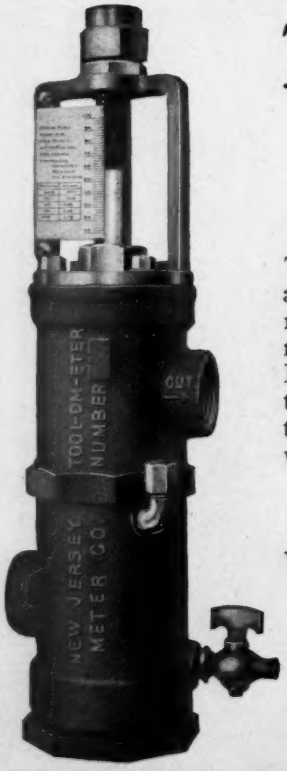
can assist you in securing a substantial bonus payable for the highest grade

Manganese-Tungsten and Chromite

concentrates. These are almost invariably slightly magnetic and by means of

The Wetherill Magnetic Separator

garnets, sulphides or other interfering minerals can be readily eliminated. More ***Wetherill*** machines are being manufactured for this purpose at present than in all previous years combined.



THE TOOL-OM-ETER

The wind bloweth where it listeth
And what do you care?
But COMPRESSED AIR costs money
And the AIR goes WHERE?

This little meter gives you the answer. Shows *at a glance* how much air is used by your sluggers, guns, jacks, japs, giants, rammers, riveters, motors, etc.—when they are new, after a month, three months, before and after overhauling and putting in new parts. Enables you to locate and remove leaks, losses and "air eaters" and to keep your equipment in effective and economical working condition. You can stop losses, decrease costs and increase your output with the same compressor capacity.

"The day of guesswork is past."

Write for further information stating what uses you make of Compressed Air.

ASK FOR BULLETIN 5-A.

NEW JERSEY METER CO.

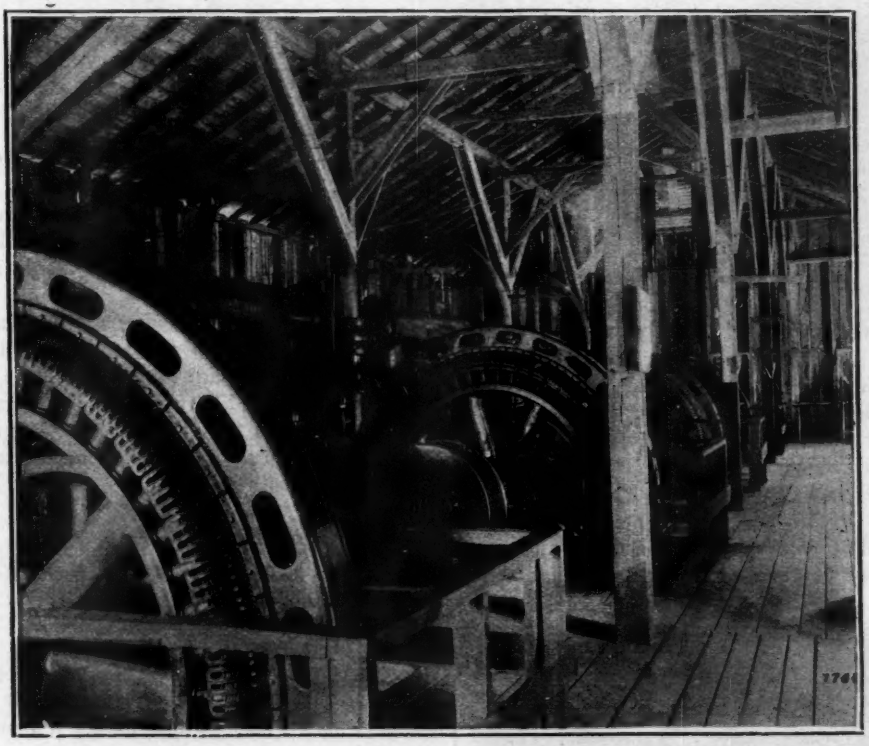
PLAINFIELD, NEW JERSEY

Tell the Advertiser You Saw His Ad. in COMPRESSED AIR MAGAZINE.

COMPRESSED AIR MAGAZINE

EVERYTHING PNEUMATIC

Vol. xxiv MARCH, 1919 No. 3



HARDAWAY CONSTRUCTION COMPANY, WHITNEY, N. C.

CONTRACTOR'S COMPRESSED AIR PLANT

By W. L. Saunders

The increasing importance of compressed air plant equipment in contracting has been the natural outgrowth of the contractors' development of methods, which demanded the introduction of tools of great ruggedness and high capacity. The success of certain characters of work, as for instance, pneumatic caisson foundation sinking, the shield method of driving subaqueous tunnels, are entirely dependent upon compressed air. It may, therefore, be safely said that compressed air plant forms an essential part of the contractor's equipment, and the problem resolves itself en-

tirely into one of the selection of that compressed air plant which will best meet his needs.

PRACTICAL APPLICATIONS

The more prominent classes of contracting employing compressed air equipment comprise the following group:

Rock Excavating

Tunneling, Shaft sinking, Road building, Foundation work, Aqueduct construction, Canal excavation, River and harbor improvements, Subways.

Structural Steel Construction

Reaming, Pneumatic riveting, Drilling, Pneumatic concrete placing, Pneumatic caisson foundation sinking.

Railroad Work

Pneumatic tamping of ballast, Spike driving, Wood boring.

Sewer, Gas and Water Main Construction

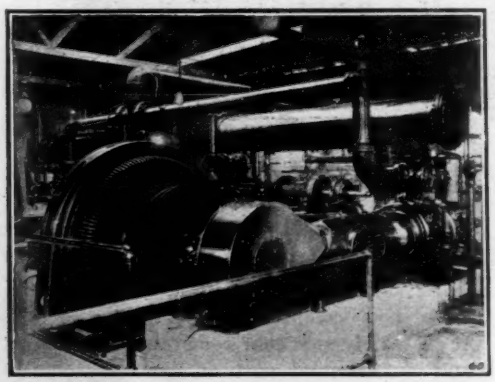
Rock excavation in trenching, Pipe caulking, Riveting, Tamping back fill.

Quarrying

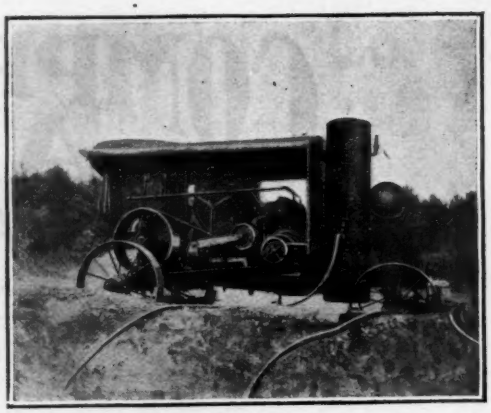
Excavation of rock for dam building, road surfacing, concrete structures, etc.

TYPE OF COMPRESSOR

The character of the work is an important feature in the determining of the size and the selecting of the type of air compressor plant; for instance, such work as tunnel driving, aqueduct construction, canal excavation, etc., might well utilize a number of semi-permanent air compressor installations, like those used by the Hardaway Construction Company, as such work usually extends over a considerable period of time. On the other hand, such work as road building, open cut excavation, trench digging, structural work, etc., could more profitably employ portable air compressor plants which move with the work, like that used by the Georgia Railway and Power Company.



HOLBROOK, CABOT & ROLLINS



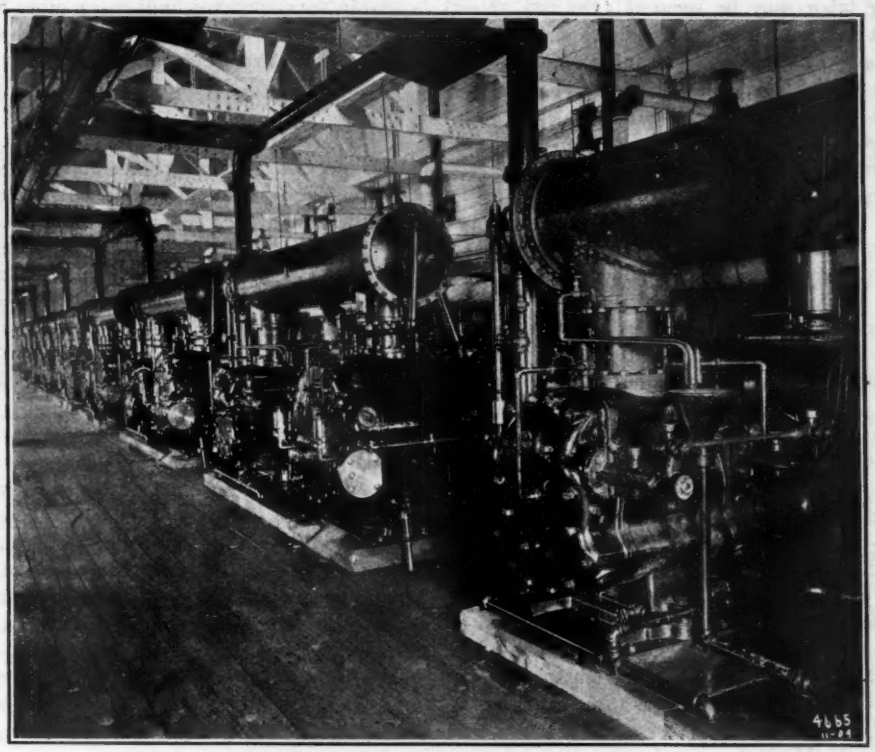
GEORGIA RAILWAY & POWER CO.

In the case of semi-permanent installations the requirements may call for the installation of both high pressure and low pressure units, the former for purposes of operating rock excavating machinery, pneumatic placing of concrete, the operation of water pumps, hoisting engines, pneumatic riveters and the like, as were used at Shaft No. 2, Brooklyn, by Holbrook, Cabot & Rollins, and the latter for supplying air to pneumatic caissons and tunnel shields, as used by Flynn & O'Rourke at Jeannette Park.

The availability of motive power will be a deciding feature in the selection of the type of air compressor, for instance, where the work is of considerable magnitude and remote from a supply of cheap electric current it becomes necessary to utilize steam driven air compressors, as installed by the T. A. Gillespie Co., with a boiler plant, which makes it more or less a permanent installation. On the other hand, where electric power is available, either direct connected electrically driven type of air compressor of the Rogler Class, where the requirements for air is large, or the short belted to motor type air compressor, Imperial type, where the requirements are small.

AIR OR STEAM PLANT?

In earlier practice it was customary to operate rock excavating machinery by steam, utilizing the boiler horse power direct, and



T. A. GILLESPIE & CO. TEN IMPERIAL CORLISS COMPRESSORS

thereby eliminating one item in the initial cost of equipment. On the other hand, the development of efficient steam operated air compressors and greatly improved compressed air operated rock drills caused the contractor to realize that he could effect more efficient and economical operation by installing an air compressor, than he could by adhering to the now admittedly obsolete practice. The greater loss experienced in the transmission of steam over long distances, as compared with that of air, and the greater consumption of boiler horse power in the rock excavating machine per unit of work, as compared with compressed air drills, more than compensated for the additional initial outlay.

OPERATING POWER

In some isolated cases where hydro-electric power could be generated on the job, the question of choice of compressor motive power is a simple one. A notable instance of such practice is that of the Laramie Pondre irrigation tunnel driven in Colorado, where Pelton water wheels were installed for driving generator sets, supplying current to short belt motor driven Imperial air compressors.

For portable compressed air plants, the choice of motive power falls naturally to gasoline driven types, due to comparative lightness of the equipment, the simplicity of operation and the ease with which satisfactory oper-

FLYNN & O'ROURKE

ating labor may be secured. On city street work it is sometimes advisable to use a motor driven portable unit, securing electric power from trolley lines or commercial power circuits. In building construction the semi-portable skid-mounted motor driven units are customarily employed.

SELECTION OF COMPRESSOR

In the selection of the air compressor, the contractor should give attention to the question of permanence of the equipment or its possible salvage value, as in the case of a large project involving the installation of an elaborate plant, upon its completion he may have no further opportunity to utilize a plant of such large capacity, and it therefore becomes necessary to salvage it. On the other hand, a portable unit invariably becomes a permanent part of his equipment. This presupposes that a high-grade plant will be in better condition upon completion of a job, and therefore return a greater salvage value.

As a case in point, a recent instance will be mentioned. In August, 1913, the E. E. Smith Contracting Co. of New York City purchased an Imperial Two-Stage Air Compressor and Receiver, and again in July, 1914, a duplicate unit. The total outlay involved an expenditure of $4,128. Upon the completion of its subway contract in June, 1916, the Smith Company disposed of these machines for $3,100. They estimated that the compressor plant had cost them practically nothing, and therefore had the use of compressed air on this job at a comparatively low cost. This particular installation was of the short belted to motor type, and in this connection it is well to bear in mind that in a unit of this sort, the changing from one contract job to another involving a change in electrical current conditions makes it necessary only to substitute one standard motor for another.

The volume of the work to be performed will determine the number of tools it is necessary to use, and this in turn will determine the size of air compressor to purchase.

AIR CONSUMPTION

Manufacturers of rock drills and other pneumatic appliances for contracting, publish figures of air consumption at various pressures, and it is, therefore, comparatively simple to determine the amount of air required to operate a given number of tools. To this should be added a margin of safety, as invariably the contractor finds many other adaptations for the air. This margin of safety will vary from 10 to 20 per cent., depending upon the magnitude of the undertaking.

INSTALLATION

With semi-permanent installations it becomes necessary to provide suitable housing and foundations of semi-permanent character. The question of housing is a simple one, the only precaution required is the protection of the plant from the elements. With work of long duration, it is advisable to install a foundation of mass concrete or stone masonry structure. This is particularly true of large machines. Machines of small and moderate capacity customarily employed on short time jobs give satisfactory service bolted to skid foundations, firmly anchored.

On penalty jobs, or in such work as pneumatic caisson sinking or shield tunneling, where the lives of the workmen are dependent on the absolute uninterruption of the air supply, it is imperative to install duplicate units, so as to insure against failure of the power supplied.

The radius of distribution of compressed air from a central station is practically without limit.

EQUATING COST

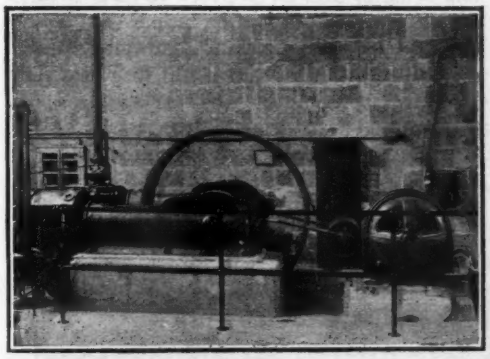
The determining factor is the balancing of the comparative cost of the installation of one large plant and the cost of transmission line necessarily large in diameter, plus operating cost, with the installation of smaller units with smaller transmission lines, plus operating cost. In the transmission of air over long distances, the cost of the air line installation may reach a point where it will more than pay for the installation of a number of small units and give more satisfactory service.

TRANSMISSION

Transmission lines will vary from 2 to 6 in. in diameter, depending upon the size of the installation and the distance of transmission. Suitable control valves should be provided at the power house, as well as the points of outlet.

In pneumatic caisson work an aftercooler forms an essential part of the air compressor equipment, it being utilized to remove the heat of compression and deliver the air to the air locks at normal temperature.

In the operation of pneumatic tools of various kinds, particularly in cold weather, some



SHORT BELT DRIVE

trouble may be experienced from freezing, and under such circumstances it becomes advisable to install some form of air reheater, which not only eliminates this trouble but increases the power delivered by the air compressing plant.

A properly designed air transmission line should include the installation of moisture traps at convenient intervals for the removal of the moisture, which the air contains and which is deposited in the transmission line.

MAINTENANCE

Modern air compressors have reached such a high state of refinement that aside from an occasional inspection to insure tightness of stuffing boxes, absence of leakage in the transmission line, and the proper functioning of the lubricating devices require very little attention on the part of the operator. Most machines have their driving parts automatically splash lubricated with force feed pumps supplying the cylinders. Air compressors for permanent or semi-permanent installation vary in size from 50 to 10,000 cu. ft. of free air per minute, pressure ranging from 15 to 125 lb. Portable air compressor plants range from 50 to 500 cu. ft. of free air per minute at similar pressures.

TAMPING "PLUMS" WITH JACKHAMERS

In building the Copco dam on the Klamath River in northern California, concrete was placed in the foundations through shafts, some of which were 125 ft. deep. Because of the limited space in the smaller shaft sections, hand tamping was slow and ineffective, interfered with the other work, and cost about 10c. per cubic yard. The specifications were exacting in regard to well-compacted concrete, and endeavor was made to improve on tamping by hand. Pneumatic tampers were tried out, and after some attention to details the tamping cost was reduced to 5c. per cubic yard.

The smaller shafts were in sections about 16x50 ft. in plan, and this space was divided by the cross-bracing into 8x16-ft. sections. In these small sections the men shoveling concrete, placing plums and tamping were frequently in the way of one another, and when the concrete was coming at normal speed it was often extremely difficult to tamp it properly.

When tamping by hand, about 100 to 150 cu. yd. of concrete were placed per day, and six to eight men were engaged in tamping. It was found that the hand tamping accomplished very little in the way of compacting the concrete where the layers were more than 3 in. in thickness, and in no case could the concrete be compacted uniformly. When a pneumatic tamper was adopted to the work, however, it was possible for four men to tamp effectively a day's run of 300 cu. yd. or more of concrete. The pneumatic tamper could not be applied directly on the concrete itself without burying the tamping head, but by tamping the plums it was found possible to compact the concrete for a depth of 2 ft. in all directions under the plum. The principal problem connected with adapting the jackhamer used to the work of tamping the plums was to find a suitable tamper head. The first attempts were with a hemispherical piece of steel about 5 in. in diameter and ½ in. thick, whose concave side was riveted or welded to an 18-in. shank of ⅝-in. hexagonal drill steel. These tamper heads would last long enough to tamp 250 to 300 cu. yd. of concrete, after which the rivets or the weld would loosen so that the head would come off. A more successful type of tamper was built by up-setting the head of a longer piece of drill and working it into the shape of a cone with a base about 3 in. in diameter. This type eliminated the difficulty of the tamper head coming loose, and gave good service for 400 to 500 yd. of concrete. It has a weakness, however, in that the shank would finally crystallize and break off just where it enters the jackhamer. But with such heavy service long life for the steel was not expected

and the economies over the hand method much more than offset the maintenance costs.

The work was carried out by the California-Oregon Power Co. forces, P. O. Crawford being resident superintendent in charge of construction and installation.—*Eng. News-Record.*

STRAIGHTENER MADE FROM OLD AIR PUMPS

By Claude T. Rice

In the machine shop of the Hecla mine at Burke, Idaho, there is a formidable-appearing as well as a much-used machine called the press or straightener. This machine was made several years ago from the air cylinder of an old compound 10x18x6x18-in. Jeanesville mine pump that was about to be sold for scrap. The cylinder is mounted vertically upon a base, which is an old compressor disk 52 in. in diameter and 6 in. thick. The water-end piston rod of the pump has been forged out into a plunger, and a lever arrangement has been mounted upon the valve chest so as to control the flow of air to the cylinders.

There are several different pieces that rest on top of the base to act as anvil blocks when pressing pulleys, etc., on and off shafts or axles, but one of the main uses of the press is in straightening old rail and pipe. By using a 4x4-in. steel bar, 4 ft. long, for a straightening block, and holding the pipe by means of discarded clamps from 6-in. rock-drill bars, and clamping one at the top of the pipe directly under the plunger, pipe up to 6 in. diameter can be straightened. For straightening rails, the same 4-in. bar is used shimmed up with thin pieces of iron. The rail is placed on this block and straightened 4 ft. at a time, working it back and forth under the plunger. As the bend in the rail is generally sideways, blocks are arranged so that pressure is brought upon the head and web of the rail rather than on the flange, and a steel block is put under the plunger so that it will press only against the head and web of the rail. The machine serves a useful purpose in salvaging old pipe, rails, and bar iron.—*Eng. and Min. Journal.*

ONE HEADER SUPPLIES ELEVEN DRILLS

One 3-in. air hose was made to supply eleven drills, in shaft sinking, by feeding to the suspended metal "header" hung from a cable in the center of the shaft just above the bottom being drilled. Even eleven 14-ft. hose lines led off from the bottom of the header. There was also one connection for a blowpipe. Eleven drills were operated and two drills were kept as spares. When all was in readiness for blasting, the header and hose were hoisted out of danger, and were lowered again when drilling was resumed. A round of 45 holes, averaging 8 ft., were drilled in 2½ to 3 hours. The 11x21-ft. shaft was sunk for the Seneca Mining Co., Mohawk, Mich.mfwy cmfwy cmf cmf ing Co., Mohawk, Mich.—*Eng. News-Record.*

LOCATING THE AIR INTAKE

By Mark Meredith

Some time ago a small belt-driven vertical air compressor was installed in a certain boiler room where there was considerable dust due to the handling of coal and ashes. It was necessary to extend the 1½-in. inlet pipe outside of the building. As the unloader was of sensitive construction, and as the least bit of dirt would make the pistons stick, causing poor regulation, considerable power was wasted because of the safety valve on the receiver releasing continually.

It was desired to connect the pipe as direct to the compressor and with as few fittings as possible, which located the end of the suction pipe between the eaves of three roofs. To keep it free from water and other obstructions a hood was made from 6-in. galvanized sheet metal pipe with a 2-in. galvanized pipe nipple. These parts were all taken from used material found about the factory. This arrangement has worked satisfactorily for about a year, and it has never been necessary to clean out the unloader nor has there been any trouble from poor regulation.—*Power Plant Engineering.*

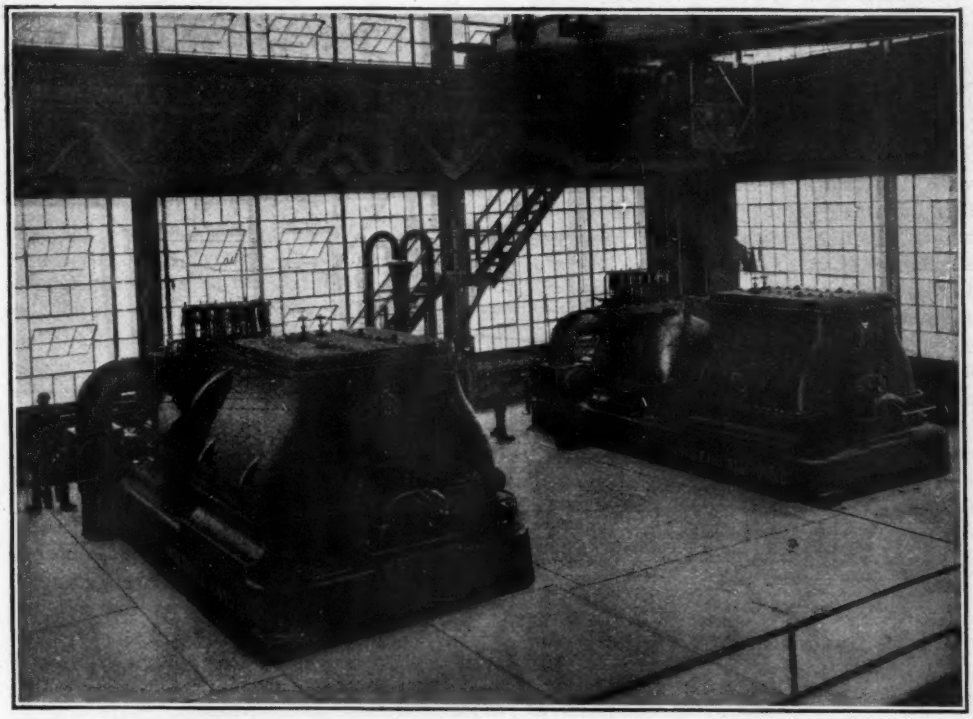
THREE-STAGE COMPRESSION FOR COTTON BALES

Raw cotton is at present loosely compressed at the gin into what is known as the "Plantation" bale with a density of about 12 pounds to the cubic foot. Only about 25 or 30 of the plantation bales can be loaded into a standard 36 foot box car. When the bale has been carried to town and sold it undergoes another compression to a density of about 22 pounds to the cubic foot. This is known as the

"Recompressed" bale, and will load 60 to 65 into a standard 36 foot car. If the bale is consigned North by coastwise steamer, or for export, it moves by rail or by river steamer to the nearest port where it takes a third degree in compression to from 32 to 35 pounds per cubic foot. This is called the "High Density" bale and will load from 100 to 150 bales into a standard car.

space is provided around the machines for dismantling and the entire area is commanded by the electric traveling crane seen in the background. Removable sections in the floor give the crane access to pumps and auxiliaries below.

A considerable quantity of compressed air at the ordinary working pressures is required for various service about the mills. To fur-

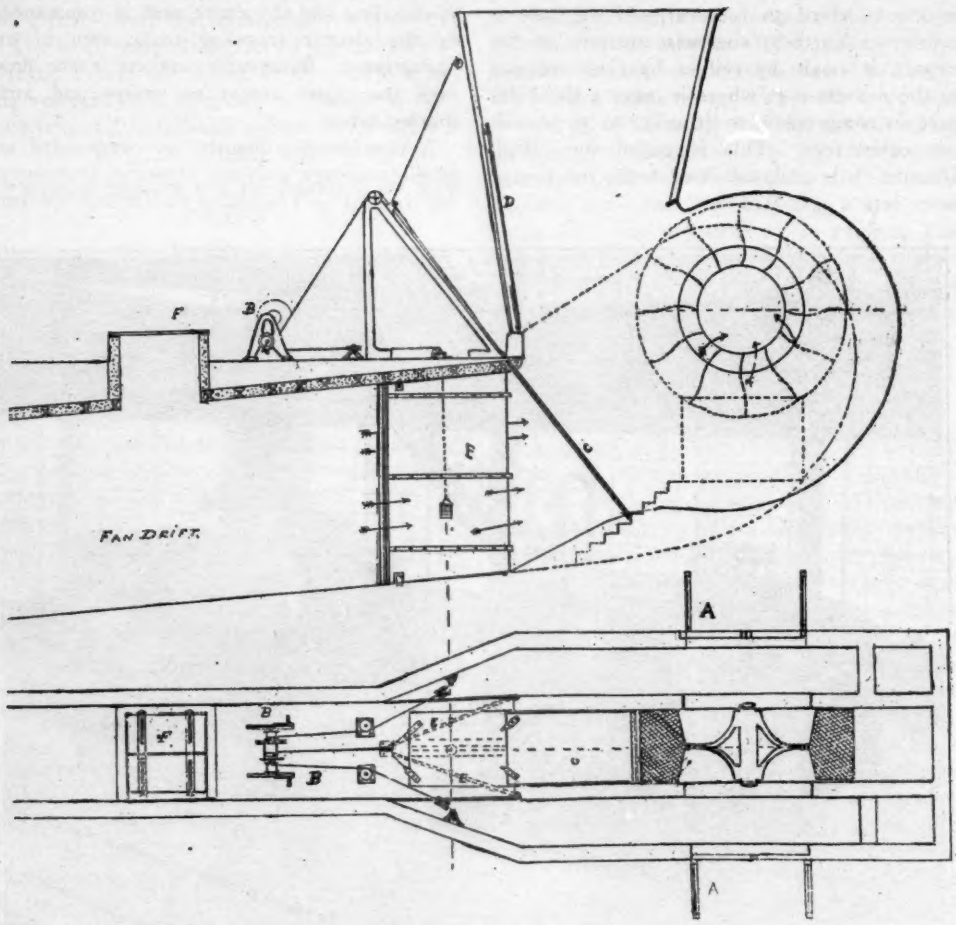


TWO TURBO COMPRESSORS AT MARK PLANT, INDIANA

LARGE STEAM TURBINE DRIVEN TURBO BLOWERS

The excellent photo here reproduced shows the turbo compressor or blower installation in the power station of the Steel & Tube Company of America at Mark Plant, Indiana. As will be seen, there are here two turbo-blowers each with a capacity of 55,000 cu. ft. of free air per min. These deliver the air at a gage pressure of 13 lb., this being conducted through an aerial line outside the power house to the blast furnace for the furnace draft. Each unit comprises an Ingersoll-Rand, 3,000 h.p., 2,500 r.p.m. uniflow steam turbine and a 5-stage blower. Liberal

nish the air for the district adjacent to this power house there is installed on the basement level an Ingersoll-Rand 10 in. and 14 in. by 10 in. duplex compressor of approximately 600 cu. ft. free air capacity, equipped with unloading valves. This compressor is driven by a 100 h.p. slip ring induction motor with short belt drive. The motor is provided with magnetic control arranged in connection with a pressure switch. When the pressure drops to 85 lb. the motor starts and the compressor runs until a pressure of 105 lb. is reached, when it stops. A storage and receiver tank of 500 cu. ft. capacity is used in connection with this equipment.



ELEVATION AND PLAN OF VENTILATION REVERSING SCHEME

REVERSING MINE VENTILATION

By J. Fox

Arrangements for reversing the ventilating currents of a coal (or any other) mine in case of a fire, or large outflows of noxious gases, have been strongly recommended by members of the Royal Commission on Coal Mines. This very important point has received the attention of Dr. J. S. Haldane, who in a paper on the possibilities of rescue work in connection with mine fires and explosions of gas and air, laid great stress upon the quick reversal of the ventilation in many cases as the best means of reducing the loss of life in such disasters.

The fan now under consideration (see illustration) affords quite a simple and effective means of carrying out Dr. Haldane's suggestion: to reverse or keep reversed (if already done so by an explosion) the ventilation of any district or mine. Owing to the great simplicity of the arrangement this, could be effected by anyone in charge without fear of failure, and without entering either the fan drift or fan house.

In following the description given, it will be seen that the change from an exhaust to a blowing ventilation is simplicity itself.

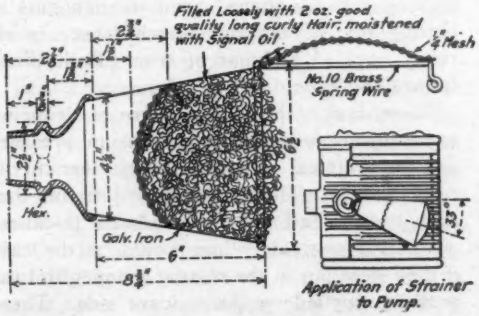
Every mining man knows that the reversal of any system of ventilation requires very great consideration before it is decided upon, and must be worked out and experimented upon under normal working conditions, to find out what would take place (and what should be done) under abnormal conditions so that

there should be no doubt about its action when taken. If the above provisions were in use it would not require a very competent person to decide to move a lever, and so reverse the current. The arrangements work as follows:—

A marks side doors fixed in the fan walls and only requiring to be opened immediately before the reversal of the ventilation is to take place. To reverse the ventilation open the doors A, then turn the winch handle B three and a half times, this at once actuating every part of the reversal gear in a complete ratio. By raising the sliding front C the covering is lowered, by the same movement, into the chimney of the fan D, and the same process gradually brings across the junction doors E, to the sides of the two former inlets, thus at once closing up the original intakes of the fan. Moreover, the doors E, in passing from the junction centre of the fan drift, at once give a clear passage for the reversed air through the doors A, the sliding front C, the junction doors E, and on into the former upcast shaft. All the various changes are made in one operation by turning the winch.

As mentioned above, it is well known that in most explosions of gas and air, there is a reversal of the air current; and by actuating the winch, as described, it would be most simple to keep the reversed current in that condition, so as to clear the foul gases out of the mine before making any change in direction; for if the air were restored to its normal course before the deadly gases were thoroughly diluted or cleared away, the latter would be sent back into the workings and claim a second lot of victims, who have, perhaps, only just survived the first deadly current from the one explosion.

It is most important that energy should be directed to affording some means that will get rid of the deadly gases that are always given off from the disastrous accidents always imminent in coal mines, and the quicker the gases mentioned above are diluted or cleared away, the fewer will be the casualties.


Filled Loosely with 2 oz. good quality long curly Hair, moistened with Signal Oil
No.10 Brass Spring Wire
Hex.
Galv. Iron
6"
8¾"
Application of Strainer to Pump.

AIR BRAKE PUMP STRAINER

In support of the arguments put forth above concerning the loss of life through CO, the chief product of such disasters, the following figures, obtained after the Hulton Colliery disaster, may be quoted:—

CAUSE OF DEATHS

CO responsible for.....	220	deaths.
Effects of explosion.....	54	"
CO and explosion.....	61	"
Asphyxia	2	"
Others causes	7	"
	344	

Much the same results were found in many disasters, including Maypole, Hamstead and Whitehaven. It will be seen that the largest loss of life is caused by CO, and to minimize these risks it is quite feasible to alter the fans at present in use, and in all new undertakings adopt such reversal fans as will do what is described. This will enable a better control of the ventilation, which, under the old order of things, often got the upper hand.

The author has had experience of fires in mines where the victims have lost their lives through the effects of CO, and it was through experiences of this kind that the protected device here described was designed.—*Collery Guardian.*

STRAINER FOR AIR BRAKE PUMPS

By E. A. M.

A simple air pump strainer, much more effective than the ordinary type which has so long been used, is shown in the drawing. In making it the casting from the old type strainer is used, and in this is inserted a cone-shaped tube of sheet metal 6 in. long by 6½ in. outside diameter at the large end. A concave screen of ¼-in. wire mesh is inserted in the tube and soldered in place 2¾ in. from the inner end. The remainder of the strainer is loosely filled with curled hair, about two ounces being required for this purpose. The outer end of the strainer is closed with a hinged lid of ¼-in. wire mesh, soldered to a light brass wire frame. A slot in the side of the tube is provided to take the latch formed on the end of the wire lid frame. In order to provide sufficient spring for the proper opera-

tion of the latch, about two inches of the frame at the latch end of the wire is left unattached to the netting. The lid is hinged to the strainer at a point opposite the latch.—*Railway Mechanical Engineer.*

REVERSED HEADS IN PRESSURE VESSELS

By James Leslie Lane

In the pioneer days of the boiler industry, when but few mathematical data on such work were available and when inspection was almost unknown outside of perhaps one or two of the larger cities, it was but natural that the reversed head should have been used. Pressures were low and strength was less important than tightness. The advantage of backing a head in was obvious. It made riveting and calking much simpler, did away with a manhole that would otherwise have been necessary, and in cases where the drum was to be stood on end avoided the use of a cast-iron base or supporting framework. There was little machinery for manhole cutting or flanging, and as this had to be done entirely by hand, the cost was considerable.

Later, when pressures increased and laws were enacted covering the construction and installation of boilers, some of the objectionable features of this practice became apparent. When the tank was set vertically, it was found impossible to drain it completely; for if the outlet was placed in the center of the head there was always water remaining below that level. Locating the outlet close enough to the bottom of the shell to remedy this fault was not only difficult, but left an opening that soon became clogged. The second drawback was that this dead space served as a settling chamber and mud catcher, where oil and sediment could collect. This feature was bad as there was always a chance that the oil would eventually find its way into the boilers and cause serious trouble. This was overcome in time by demanding that tanks so constructed should be set horizontally. But there were other difficulties to contend with, especially in regard to strength.

The matter of calculating the ultimate bursting pressure of a head inserted in the regular manner, and hence its safe pressure, is not a difficult problem, although it is somewhat complicated by the fact that a bending moment is introduced at the point where the flange and the head proper join. This causes the head to breathe slightly under excessive pressure, but the error it introduces into such calculations is not serious. The case of a bumped head resisting collapsing pressure is far more difficult, however, as it is somewhat analogous to buckling in bars. If the cross-sectional area of a bar is known, as well as the tensile strength, its ultimate rupturing strength can be accurately determined. What the same bar will do under a compressive stress depends on its shape, length, manner of applying the stress, etc. The formulas for determining its resistance to buckling are mostly empirical; that is, deduced from actual experience and tests. The same is true of bumped heads, the number of factors introduced and the uncertainty of their action making a clear-cut and exact mathematical formula out of the question.

Not a little hinges also on the individual workmanship and the accuracy with which the head is shaped to a given radius. Before collapse can begin, some small part of the head must be flattened by the pressure. This is difficult if the curvature is exactly the same at all points on the sphere and the stresses set up in it are balanced; but if in the beginning some small portion is left flat and a leverage afforded the tendency to collapse is cumulative. In fact, it might be said with fair accuracy that in every case where such failure occurs under pressure the beginning was made at a flat spot.

Where the pressure is on the concave side, such a fault tends to correct itself by forming the head to a circle; in a reversed head it tends to accentuate itself and lead to a failure of the whole. Accurate workmanship cannot, therefore, be too strongly insisted upon. Installing a badly shaped head is analagous to putting into a building columns that are already buckled and out of true. Both invite failure and should not be tolerated.

These faults, the impossibility of deducing an accurate formula for collapsing pressure and the practical certainty of imperfect curvature, have been allowed for by stipulating that such heads shall have a minimum thickness considerably greater than would be the case if they were put in the regular manner and the pressure applied on the concave side. These restrictions take care of the stresses set up in

the head itself, but do not allow for the effect of breathing or swaying on the shell.

Turning to Fig. 1, observe what form the bumped head will first assume when a distorting pressure is applied, and what stresses it will develop in the shell. The problem is similar to buckling in a beam, and whatever distortion appears will be about the neutral axis *AA*, no effect being noticeable at the points *B* where the axis cuts the head.

If the part *BB* is to bulge outward finally, it must first be flattened, the part *BC* of the head being distorted and assuming the shape shown in Fig. 2. This places the part *BC* in compression and the stress will be exerted along the tangential line *XX*. Without attempting to determine the exact intensity of this stress, assume it to be *M* pounds and resolve it into its two components, one parallel to the axis of the shell, the other at right angles to it.

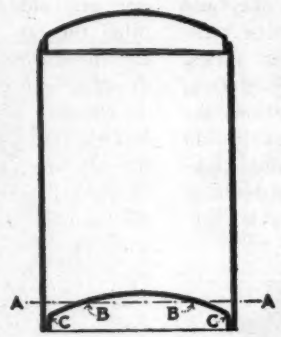


FIG. 1

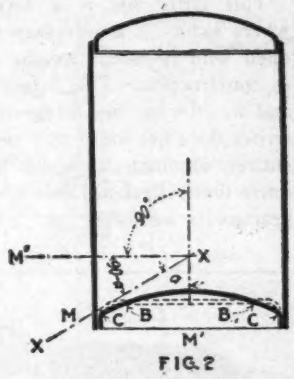


FIG. 2

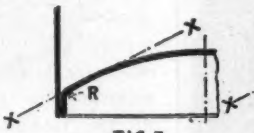


FIG. 3

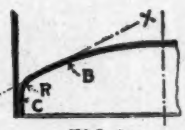


FIG. 4

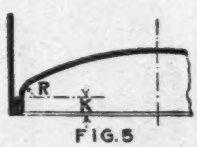


FIG. 5

THE REVERSED HEAD IN THE AIR RECEIVER

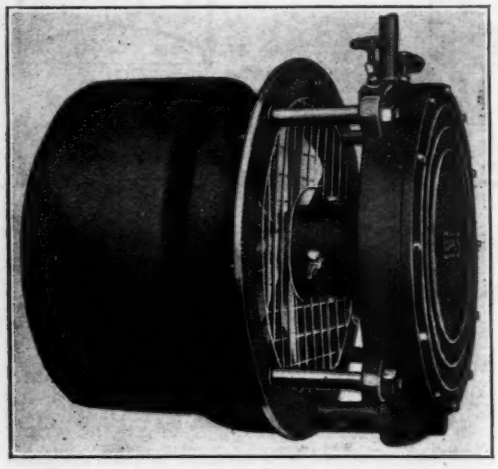
Supposing that the line *XX* makes an angle *a* with the axis of the shell, then the force *M'* acting parallel to the axis of the drum will be *M* cos *a* and its effect will be wholly exerted on the rivets holding the head in position. The force *M''* acting at right angles to the axis of the drum will be *M* cos (90 deg. *a*) and its effect will be partly exerted on stretching the metal in the part *BC* of the head, and in expanding the shell of the drum itself. To put the problem in a simpler way, the action is a toggle effect, the outer rim of the head being stretched and forced out against the shell, tending to rupture it.

Just how much of this toggle effect is brought to bear on the shell of the drum depends on the radius *R*, where the head meets the flange. If the radius is small, as in Fig. 3, then any expansion of the head must affect the shell, for the thrust comes directly against it. On the other hand, if this radius is large, as in Fig. 4, the part *BC* of the head is free to spring and the stretching of the shell is minimized. This would lead to the conclusion that in reversed heads the radius at the knuckle of the flange should be considerably larger than in the case of straight dished heads of the customary type. In order to reduce still further this toggle effect, the writer believes it would be advisable to insert a filler piece between the flange of the head and the drum, as shown in Fig. 5. It need not be thick —probably one-eighth inch would be sufficient —and where possible it should be of copper. Its width *K* should not exceed 2½ in., in order that a clear space be left above to take care of any expansion of the head.

Summing up, then, the advantages of a reversed head are: (1) The possible elimination of a manhole where the drums are small; (2) the elimination of a cast-iron base or supporting lugs where the drum is to be set in a vertical position; (3) the possibility of doing the riveting on a bull.

Opposed to these are the following disadvantages: (1) The impossibility of proper draining, with the attendant danger that oil may find its way into the boilers; (2) the settling chamber formed, and the danger of clogging the outlet pipes; (3) the additional thickness of plate required; (4) the wholly empirical formulas on which such plate thickness must be based; (5) the ever-present element of danger due to faulty curvature; (6) the additional load that such construction puts on the shell joints.

This latter list is a formidable one, and where safety is a necessary factor to be reckoned with it far outweighs any initial saving in construction. The defects are too glaring, and in offering the foregoing suggestions the writer does not mean that such changes would entirely eliminate them, but would rather minimize their effect in cases where such doubtful practice is adopted.



COPPUS TURBO BLOWER

TWO TURBO BLOWERS

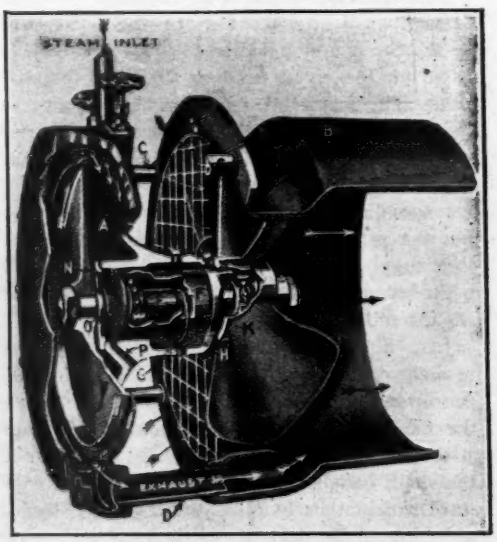
A considerable demand has developed for self contained unit blowers capable of reliably delivering considerable volumes of air at slight pressure. These are used for producing draft in boiler furnaces and for various ventilation service. The two examples here illustrated are both steam driven and in many respects resemble each other.

THE COPPUS TURBO BLOWER

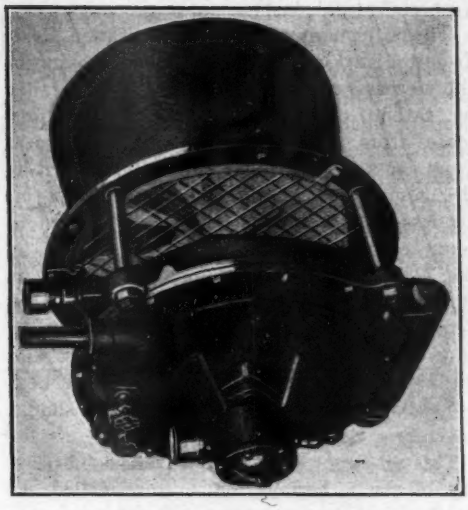
This blower, built by the Coppus Engineering & Equipment Company, Worcester, Mass., has the following features of construction: The casing *A* is supported from the fan casting *B* by studs *C* and the exhaust pipe *D*. The shaft *E* with its ball bearings is mounted within the motor bushing *F*, which is provided on both ends with enclosures. The complete motor is inserted bodily into the housing of the turbine casing and forms with it the oil chamber *G*. The oil ring *H*, which hangs from the shaft into the oil chamber delivers the oil constantly to the bearings, after which the oil is returned to the chamber. The shaft carries one one side the turbine disk and on the other the fan. Provision is made for sealing the turbine casing so that no exhaust steam or water can enter the oil chamber, while the oil chamber is also sealed to prevent oil from leaking out. When the oil chamber is filled the oil level is approximately at the center of the balls of the bearings and the two upper oil chambers on each side of the dam form with the lower oil chamber *G* an enlarged reservoir. As long as the oil supply does not diminish, the function of the oil ring *H* is simply to create a circulation of the oil through the ball bearings.

When the oil supply diminishes, the original oil level in the upper oil chambers is still maintained so long as the oil ring touches the oil in the lower oil chamber *G*. To fill the oil reservoir the plug *L* at the top of the hub of the turbine casing is removed and the overflow pet cock at the side of the casing is opened. When oil flows through this pet cock it is closed and the plug *L* replaced. When it is desired to clean or refill the oil chamber, the plug *M* is removed.

To facilitate repairs the bearings are mounted in the motor bushing which is inserted in the hub of the turbine. If any of the moving parts of the machine should need attention the bushing can be removed as a whole.



DETAILS OF COPPUS BLOWER



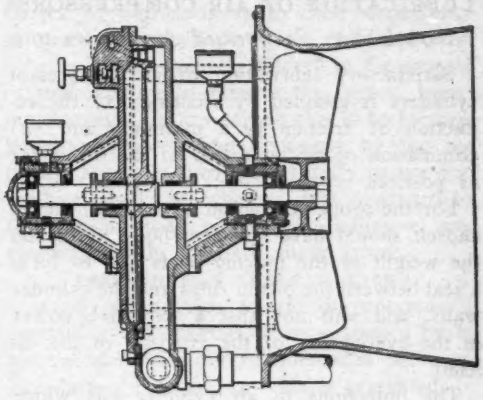
CARLING TURBO BLOWER

The casing closely hugs the fan and is expanded immediately beyond. This relieves any choking effect on the air by the casing, eliminates friction and prevents the formation of eddy currents.

THE CARLING TURBO BLOWER

In this machine the fan casing is said to be constructed on the Venturi principle which allows a free flow of air, gives high efficiency and makes the blower practically noiseless. The turbine casing is constructed with a safety ring in combination with the turbine cover, so that damage by excessive rotor speed is prevented. The turbine cover contains a steam chamber, nozzle port and controlling valve. A removable plug is placed opposite each nozzle to allow inspection. The construction of the turbine is such that a back pressure up to 15 lb. may be carried, and the exhaust-steam connection is designed so that it may be diverted from the ashpit and piped to a feed-water heater if desired. Each blower is supplied with a steam strainer to prevent scale and other foreign matter from getting into the nozzles and clogging them.

The controlling valves close against the steam pressure, thus allowing them to be packed without shutting down the blower. The nozzles are made of tobin bronze and are so inserted in the casings that they cannot work loose and get into the rotor blading. The rotor is made of phosphor bronze and is of



SECTION OF CARLING BLOWER

the impulse type. The blades are of cupro nickel and are so inserted in the rotor that they cannot work loose. They are further protected by a band riveted around the entire periphery. The stuffing-boxes are cast to go with turbine casing and cover, and anti-friction metallic packing is used in them. Two bearings are used with the turbine rotor supported between them. They are of the ball-bearing type.

The fan is made of aluminum, the pitch of the blade being such as to give the maximum amount of air with the least expenditure of power.

Built by the Carling Turbine Blower Company, Worcester, Mass.

PNEUMATIC TRAVELER FOR ELECTRIC CONDUITS

After the conduits for electric wires have been laid, usually underground, there remains the job, by no means a simple one, of stringing the wires through them. One of the most recent devices employed for this purpose is air-operated, the entire rig comprising a hand pump, a pressure tank, flexible air hose, reel for cord and a traveler. The traveler is a small shaft carrying three light disks, each of which forms a more or less perfect piston with the conduit bore for the cylinder. When air pressure is applied the traveler is impelled along the conduit, straight or curved and following the crooks and elbows. A cord is pulled by the traveler and when the other end is reached this cord is used for pulling the wires through.

LUBRICATION OF AIR COMPRESSORS*

Copyright by Compressed Air Society 1919.

Satisfactory lubrication of air compressor cylinders is attained by securing (1) the reduction of friction to a minimum and (2) elimination of carbonization of the oil as far as possible.

For the proper reduction of friction, the oil chosen should have sufficient body to sustain the weight of the moving parts and to form a seal between the piston rings and the cylinder walls, and still not absorb excessive power in the overcoming of the viscosity of the oil itself.

The objections to air cylinder oils which allow more than the very slight amount of carbonization which appears unavoidable, are, of course, well known but may be briefly stated for the purpose of clarifying what follows:

Carbonization of the oil allows the accumulation of deposits of carbon which are sticky in the early stages of their formation but hard and flinty later. Such deposits accumulate on the cylinder valves, in the cylinder passages, in the pipes and eventually in the air receiver.

Sticking or partial closing of the valves and their consequent failure to act properly is probably the chief objection to this action from the standpoint of the efficient operation of the compressor.

The formation of excessive carbon deposits is apt to be due to any one or more of the following causes:

1. The ill-advised use of some oil, such as a steam cylinder oil, which easily decomposes in the heat of the air cylinder.

2. The use of oils of too great a viscosity —commonly referred to as "too heavy oils." These do not atomize readily and, therefore, remain too long upon the hot cylinder walls, etc., thus baking down to sticky carbon deposits.

3. The use of too great quantities of oil, which has the same effect as the use of too heavy an oil as far as the carbonization is concerned.

4. The failure to provide a proper screen over the air intake of the compressor, thus allowing free entrance of dangerous dust (especially coal dust).

The objections to this carbonization aside from the sticking of air valves and choking of the air passages is the menace of fire entailed by carbon deposits. Carbon particles torn loose from them may become incandescent from causes which could not be anticipated by the compressor manufacturer. If such incandescent carbon particles should happen to come in contact with "oil vapor" given off by the lubricating oil, a fire might possibly be started whose menace would be small or large depending upon how much carbon had been allowed to accumulate in the compressor and the piping to the receiver. If these are kept properly cleansed at all times, there should never be a time of any danger.

This oil vapor is given off from a lubricating oil at a certain temperature called its "flash point" just as steam arises from water at a certain point.

HEAT OF AIR COMPRESSION

The selection of an air cylinder lubricant is of course, governed to a considerable extent by a knowledge of cylinder temperature it must withstand. Knowing the air pressures, the corresponding temperatures are ascertained fairly accurately, as shown in Table No. 1.

TABLE NO. 1.—CYLINDER TEMPERATURES AT END OF PISTON STROKE

Air Compressed to lbs. gage	Final Temperature F. Single Stage	Final Temperature F. Two Stage
10	145	
20	207	
30	255	
40	302	
50	339	188
60	375	203
70	405	214
80	432	224
90	459	234
100	485	243
110	507	250
120	529	257
130	550	265
140	570	272
150	589	279
200	672	309
250	749	331

This table gives the final temperature in the cylinder at the end of the compression stroke,

*By H. V. Conrad, Mechanical Engineer, Secretary Compressed Air Society, New York City. Printed from advance sheets.

for single stage, also for two stage (or compound) compression, when the free air entering the cylinder is 60 degrees F.

Variations from these temperatures will occur in actual practice, due to water jacketed air cylinders and radiation, tending to lower the temperature at the higher pressures. But at, say, 50 pounds pressure and lower, the heat is likely to be somewhat greater than given by the table, particularly if the compressor is run at high speed and also if it is not water jacketed.

OIL FLASH POINT AND CYLINDER TEMPERATURES

The natural inference of the reader after noting the temperatures in Table 1, is that he must select an air cylinder oil whose flash point is higher than the maximum temperature apt to be encountered within the air cylinder. As a matter of fact, this is not the case, and it need only be carefully noted that the study of the air cylinder temperatures is useful mainly in testing lubricating oils to determine their resistance against breaking down into carbon, etc. But such temperatures cannot be taken as limits establishing the highest allowable flash point for a lubricant safe to use in the air cylinders.

QUALITIES OF CYLINDER LUBRICATING OILS

For average normal conditions, the oil should be a medium bodied pure mineral oil of the highest quality, not compounded with fixed oils such as animal or vegetable, and should be carefully filtered in the final process of manufacture.

Quite a range of oil composition is permissible for lubricants approved for this work, which are manufactured under the above conditions. Primarily a distinction must be made between those oils having a paraffin base as distinguished from those having an asphaltic base.

From a strictly operating standpoint—so it is claimed by some lubricant manufacturers—there is no distinction between these two classes of lubricants as to their desirability as compressor cylinders oils, provided that both have been properly filtered in the process of manufacture to remove the carbon forming elements. If any carbon should be formed, however, such carbon deposited by the asphaltic base oils is of a light fluffy nature and easily cleaned out, whereas, that deposited by the paraffin base oil is very adhesive, and characterized by the hard, flinty nature.

PARAFFIN BASE LUBRICATING OILS

Merely as a guide to aid the operator in specifying the qualities to be possessed by an air cylinder lubricant recommended for average duty, the following table is presented:

Table No. 2—Physical Tests of Paraffin Base Oils

	Minimum	Average	Maximum
Gravity, Baume	28 to 32 deg.	25 to 30 deg.	25 to 27 deg.
Flash Point, Open Cup	375 to 400 deg. F.	400 to 425 deg. F.	425 to 500 deg. F.
Fire	425 to 450 deg. F.	450 to 475 deg. F.	475 to 575 deg. F.
Viscosity (Saybolt) at 100 deg. F.	120 to 180 sec.	230 to 315 sec.	to 1500 sec.
Color	Yellowish	Reddish	Dark Red to Green
Congealing Point (pour test deg. F.)	20 to 25 deg. F.	30 deg. F.	35 to 45 deg. F.

It is suggested that those oils within the range expressed by the minimum figures be used for light duty of low-pressure and temperatures, while those expressed by maximum figures should be used for high pressures and temperatures.

It is recommended that any paraffin base lubricant intended for use in "all standard air compressors," should meet the physical tests imposed by the average range of figures given in the middle column of the above table. The above wording "standard air compressors" is to be interpreted as including the following types of machines:

a Low pressure up to 100 lb. compressors, which may be either small sized single stage units, or larger sized compound machines.

b High pressure compressors which are constructed with the proper number of stages so that no excessive temperatures are ever reached.

In other words, this lubricant of average test figures is always recommended unless a compressor manufacturer specifies in his printing that a high flash point oil should be used to meet the conditions peculiar to his machine. It is thus obvious that it is never necessary that a lubricant should possess a flash point

as high as 500 degrees unless abnormal conditions of high temperature prevail. Such high flash point oils have an unusual tendency to produce carbon deposits.

ASPHALTIC BASE LUBRICATING OILS

This group of oils is considered separately for the reason that the lower limit of gravity stated in the above table, viz., 25 deg. baume, eliminates this entire group from consideration—which is not the intention of this article.

As a guide for the selection of suitable oil, the following table is given:

Table No. 3—Physical Tests of Asphaltic Base Oils

	Minimum	Average	Maximum
Gravity, Baume	20-22 deg. F.	19.8-21 deg. F.	19.5-20.5 deg. F.
Flash Point, Open Cup	305-325 deg. F.	315-335 deg. F.	330-375 deg. F.
Fire	360-380 deg. F.	370-400 deg. F.	385-440 deg. F.
Viscosity (Saybolt) at 100 deg. F.	175-225 sec.	275-325 sec.	475-750 sec.
Color	Pale Yellow	Pale Yellow	Pale Yellow
Congealing Point (pour test)	0 deg. F.	—0 deg. F.	—0 deg. F.

For general all around use, it is conceded that the recommendations given in Tables No. 2 and No. 3 above cover the situation as well as possible, special cases, of course, requiring investigation and special consideration before making recommendations.

PROPER QUANTITY OF LUBRICATING OIL

The quantity of lubricating oil to feed to the air cylinders of compressors, cannot be stated in exact terms, due to the varying viscosity of different oils, the heat of compression and the size of cylinder. It may be stated in general, however, that after the cylinders have acquired smooth and polished surfaces, the quantity should be reduced to the lowest limit to avoid the possibility of the accumulation of carbon and sooty deposits within the system due to excessive use.

The following basis of quantity given in Table No. 4 is recommended, subject to above modifications for these cylinders or equivalent sizes, operating under normal conditions.

It will, of course, be carefully noted and clearly understood that the results in the last column of Table No. 4 are based upon the assumption that under average conditions of temperature and usual range of oil viscosities, a pint of oil will contain an average of about 16,000 drops. It is of course understood that these figures are offered merely as an approximate guide and that every individual must exercise his own judgment in modifying them wherever his own particular set of working conditions is unusual.

A leading authority on compressor engineering contributes the following: "The best way to determine the proper amount of lubrication is to take out the valves from time to time and examine the cylinder. All parts should feel that there is oil thereon. If they feel dry, the lubricators should be adjusted to feed a little more oil, whereas if oil lies in the cylinder and its parts show excessive oil thereon, the quantity fed by the lubricators should be reduced. By thus examining the machine a few times, the proper amount of oil can be determined to suit the characteristics of the particular lubricant used and the conditions under which the machine operates." This is a better way to finally determine the quantity of oil required than by adopting without this experimenting any tabulated number of drops.

PERIODICAL CLEANING OF SYSTEM

The best of lubricating oils will cause the deposit of enough carbon in the compressor system to necessitate the periodical cleaning of it. For the removal of carbon, the machine operator should confine his efforts to the use of soap suds. A good cleaning solution is made of one part soft soap to fifteen parts water. These suds should take the place of oil for a few hours, and be fed into the air cylinders about once a week, either by means of a hand pump or through the regular lubricator at a rate about ten times as rapid as that of the oil. The cleanliness of the air valves when inspected, as they should be periodically, will indicate whether greater or less applications of the soap suds should be made. After using

Table No. 4—Quantity of Air Cylinder Lubricant Required per 10 Hour Day

Diameter of Cylinder Inches	Size of Cylinder Inches	Displacement per Minute Cubic Feet	Piston Speed Feet Per Minute	Sq. Ft. of Cylinder Wall Swept by Piston	Drops Oil per Minute	Drops Oil per 10 Hrs.	Sq. Ft. Oiled per Drop	Number Pints Oil Required per 10 Hrs.
8	8 x 8	120	344	718	1	600	718	.0375
12	12 x 12	320	408	1230	2	1200	613	.0750
18	18 x 18	880	496	2340	4	2400	585	.1500
24	24 x 24	1730	550	3450	6	3600	575	.2250
30	30 x 30	2940	600	4700	8	4800	590	.3000
36	36 x 36	4550	644	6070	10	6000	607	.3750
42	42 x 42	6700	696	7600	12	7200	633	.4500

*Figures of last column are based upon an estimated 16,000 drops per pint of oil at 75 degrees Fahr.

soap suds, open the drain cock of the air receiver, and of the intercooler in the case of compound machines, to draw off any accumulated liquid. Oil should be used again for half an hour before shutting down the machine in order to prevent rusting the cylinder and its fittings. Never use kerosene, gasoline or lighter oils in an air cylinder for any purpose whatever, because of their volatile nature under heated conditions.

CLEANING AIR RECEIVER AND PIPING

It often happens that oil, carbon and other foreign matters are deposited in the air discharge lines and air receiver. A practical method of cleaning is shown on the following page, where a receptacle made of 6-inch pipe is shown set on top of the discharge pipe. The cut shows plainly the construction and what the different parts represent. If a mixture of one pound of Red Seal Lye and eighteen pounds of water is passed into the discharge line at the rate of 60 or 70 drops per minute, while the compressor is running, this will eat out all the accumulation on the surface of the pipe and in the receiver, and if the blow-off valve on receiver is open, all of this foreign matter will be discharged therefrom. This cleaning solution can be used every month or two depending on how much accumulation there may be in the receiver.

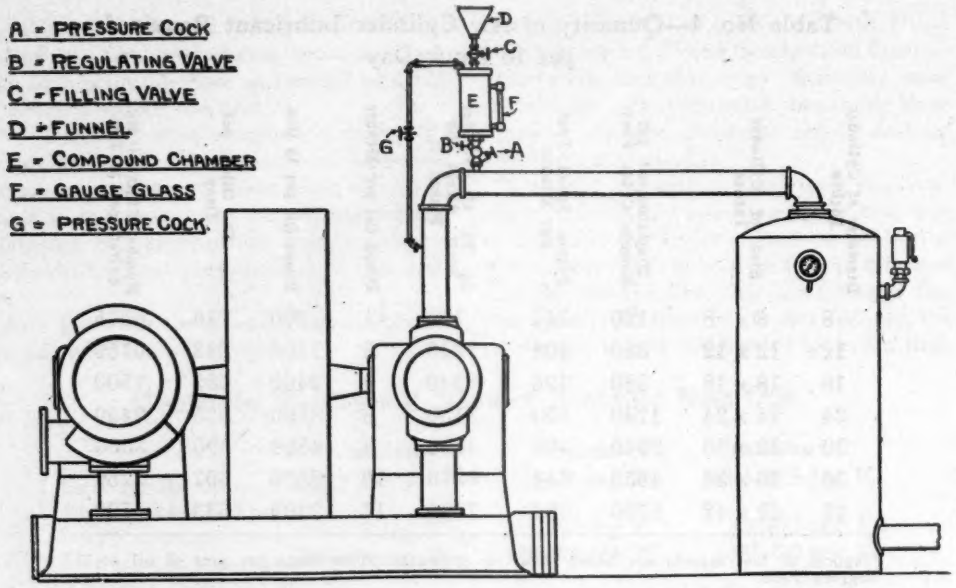
STEAM CYLINDER LUBRICATION

The proper quantity of oil to be fed to steam cylinder is much greater than to air cylinders, due to the constant washing away of the oil by the steam. Approximately four times as much oil will be needed in the steam cylinders as in those for air, subject, of course, to variable local conditions.

Depending on its viscosity, a pint of steam cylinder oil will furnish from 5,000 to 8,000 drops, and taking an average of about 6,500 drops, and four times as much oil as air cylinders of same size, and working at same piston speeds, as given in Table No. 3, the

Table No. 5—Quantity of Oil for Steam Cylinder Lubrication

No. Drops Per Minute	Size of Cylinder Inches	Number Pints Oil Required per 10 Hours.
4	8 x 8	.4
8	12 x 12	.75
16	18 x 18	1.5
24	24 x 24	2.25
32	30 x 30	3.0
40	36 x 36	3.75
48	42 x 42	4.5



COMPOUND:—MIX 1 LB. OF RED SEAL LYE TO 18 LB. OF WATER.

To Use Compound: Close Cock "A" and "G," open Valve "C" and fill Compound through funnel "D," when chamber "E" is filled Close Valve "C," Open Cock "G" and "A" and Regulate Feed by Valve "B;" Use about 70 Drops Per Minute.

DEVICE FOR CLEANING CARBON IN AIR DISCHARGE LINE AND RECEIVER OF AIR COMPRESSORS

recommended amounts to feed the steam cylinders or their equivalents are given in Table No. 5.

These figures are approximate only, and will vary with the steam conditions, the kind of oil used, and its method of introduction into the steam, also with the boiler compound carried by the steam into the cylinder.

ABOUT CHANGING TESTED OILS

When the operator of an air compressor succeeds in obtaining lubricating oils that are giving satisfactory results, he should be very cautions about making a change to other grades, particularly if cheapening the cost is advocated by purchasing and sales agents. But if a change is decided on, the performance of the new lubricants should be most carefully checked up before damage can occur to the rubbing surface of the compressor, and to see that no increased amount of deposit collect on the inside walls of the air receiver.

The most satisfactory way to get the quickest results is to put up the problem of lubrication to the local experts of any reputable lubricating companies, and to be governed by their recommendations, which, however, should be based on the foregoing statement.

AIR INTAKE EXPERIENCE

It was discovered that the intake pipe of an air compressor had parted sufficiently to permit the entire air supply to be taken from a point indoors, below the cylinder. A thermometer placed at the break showed a temperature of 100 deg. F., while the temperature out of doors was 47. Since the loss in efficiency equals about 1 per cent. for each 5 deg. rise in temperature of the air supply, it will be seen that the loss in this case was over 10 per cent.

This compressor carried a constant load, a smaller one taking care of variations, and after repairing the break an appreciable difference could be noticed in the load carried by the smaller machine.—*Power.*

Nearly nine-tenths of the total estimated coal deposits of the United States, or about 3,550,000,000,000 tons, (3 million million+) are stated to lie at a depth not exceeding 3000 ft. below the surface.

DANGERS OF EXPLOSION WITH INFLAMMABLE LIQUIDS AND VAPORS*

BY W. PAYMAN

The danger of explosion due to the ignition of mixtures of inflammable vapors and air is present in many common industrial occupations. It is important that the extent of this danger should be realized so that necessary precautions may be taken when handling or using liquids, such, for example, as benzol and gasoline, which yield inflammable vapors. The exact determination of the factors which decide the liability of a given liquid to give explosive mixtures presents a number of experimental difficulties and perhaps for this reason, has not attracted many investigators; but some information of value to technical chemists may be found scattered in chemical literature.

The nature of the danger to be apprehended during the use of inflammable liquids will depend upon the process or processes being employed. These may be divided roughly into three classes:

(1) Processes in which the liquids are used for crystallisation, precipitation, or as solvent media, or where they are being chemically treated as in sulphonation and nitration.

(2) Processes carried out in drying stoves or rooms, heated externally or by hot air blast, in order to remove the liquids from finished chemical products, with or without the subsequent recovery of the vapors by condensation or washing.

(3) Storage of liquids in tanks, and their transfer therefrom to plant or containers.

Throughout all such operations the danger arising from accidental leakage must also be taken into account.

The two most important criteria for judging the liability of a given liquid to produce dangerous conditions are:

(1) The volatility of the liquid.

(2) The range of explosion of the vapor when mixed with air.

RANGE OF EXPLOSIBILITY

Each inflammable vapor has a definite range of explosibility when mixed with air. Mixtures containing less than a certain percentage of vapor, known as the lower limit of inflammability, will not allow the continued propagation of flame, though a source of heat intensity may cause a logical ignition. If the percentage of vapor be increased, a point, called the upper limit of inflammability, is at last reached when the mixture is again incapable of propagating flame, and no mixture containing a greater percentage of vapor than this upper limit mixture will give more than a local inflammation.

The limits observed experimentally differ slightly with different positions of the point of ignition, as the flame may be helped or retared by convection currents according to whether it has to pass upwards or downwards.

It will be understood that, other things being equal, a vapor which gives with air mixtures having wide limits of inflammability will be more dangerous than one having narrow limits. For example, acetone, with a range of 6.15 per cent. (i. e., between 2.35 per cent. lower and 8.50 per cent. upper limit of inflammability), is more dangerous than benzol, with a range of only 3.3 per cent. (1.4 to 4.7 per cent.). The appended table gives the limits of inflammability of the commoner organic solvents as recorded by different observers.

The vapor pressure of the liquid may be so small at the temperature at which it is used as to be incapable of forming a lower limit mixture with the surrounding air. On the other hand a highly volatile liquid may easily give mixtures which are above the upper limit of inflammability. In the latter event it is important to note that the full range of inflammable mixtures has to be passed through before the percentage of vapor in the air renders the mixture safe; and, when this "safe" mixture has been attained, if the chamber be opened at any time to the outer atmosphere an explosive mixture would soon be formed by the inward diffusion of additional air.

From a knowledge of the vapor pressures of an inflammable liquid at different temperatures, coupled with a knowledge of its "limits," we can predict the working temperature at which the vapor pressure is (1) just sufficient to give a lower limit mixture, and (2) just sufficient to give a higher limit mixture. What may be termed the lower limit temperature of a volatile liquid corresponds in a sense to the "flash point" of an oil, though the latter, as determined by the recognized methods, has no

*Journal of the Society of Chemical Industry.

absolute meaning, the results being only relative. It must be remembered, however, that still air does not become saturated with a vapor for a considerable time, and so both the calculated limit temperatures may be lower than those actually required in practice to obtain the limiting compositions. Again, an increase in temperature widens the limits of inflammability, but from analogy with experiments with methane-air mixtures, it is unlikely that this effect will be appreciable over the range of normal working temperatures.

Two other factors are of importance when considering the inflammability of vapors:

(3) The speed of propagation of the flame in the mixtures with air.

(4) The ease of ignition of the mixtures.

The speed of propagation of flame is important whenever explosive mixtures are liable to be produced in long mains, as, for example, with acetone-air mixtures during the stoving of cordite. It should be noted that the speed of the flame in mixtures of a given vapor with air varies with the vapor content, being at a maximum when the percentage of vapor lies about midway between the limits, and falling rapidly as the limiting compositions are reached.

When considering the prevention of explosions, careful attention must be paid to the possibility of ignition of vapor-air mixtures by mechanical means, due to faulty or normal working of machinery in contact with the vapors. Sparks caused by grinding of ill-fitting parts, or the overheating of bearings due perhaps to similar causes, may be mentioned as possible sources of ignition. Unfortunately very little information is available on this point. Its importance has long been realized by mining engineers, but they have only examined the special tools and machinery used in coal mining to see whether sparks caused in operation would be powerful enough to ignite mixtures of firedamp and air.

The prevention of explosions during storage and transference of inflammable liquids has perhaps received most attention. It will be readily understood that the use of compressed air for moving inflammable liquids from vessel to vessel is attended with great danger. In its place compressed flue gas, nitrogen, carbon dioxide or other "inert" gas may be used with advantage, as the risk of explosion is no longer present if there be insufficient oxygen in the atmosphere in contact with the liquid. In this connection reference may be made to some work by Burgess and Wheeler, which showed that if the oxygen content of the air was reduced below 13.25 per cent. no mixture of methane with such an atmosphere was capable of propagating flame. The same point, and also the effect of added carbon dioxide, has been studied by Clement (U. S. A. Bureau of Mines, Tech. Paper 43, 1913; J. S. C. I., 1913, 32, 1149). The addition of carbon tetrachloride, used largely in fire extinguishers, has been suggested by many authors as a means of rendering liquids non-inflammable, but according to Pfister the quantity required to be thoroughly effective is far greater than the volume of liquid treated.

Methods of Extinguishing burning liquids are discussed by Burrell (U. S. A. Bureau of Mines, Tech. Paper 127, 1915), who also describes the precautions necessary in handling inflammable liquids.

TABLE

Substance.	Power limit. %	Corresponding temp. °C	Upper limit. %	Corresponding temp. °C
Benzene	1.4	−5	4.7	5
Toluene	1.4	7	4.7	30
Ethyl Alcohol.	4.0	15	13.6	35
Methyl Alcohol	7.8	13	18.0	26
Ethyl Ether..	1.8	Below −30	5.2	−28
Acetone	2.35	Below 20	8.5	Below 20
Carbon Bisulphide	4.1	Below 20	—	—
Petroleum Benzine	1.1	—	3.8	—
Gasoline	1.5	—	5.3	—
Pentane	1.35	Below 0	4.50	Below 0

In general, the precautions to be taken to prevent explosions will depend upon the individual process, but enough will have been said to indicate the factors to be considered in devising suitable methods. The limits of inflammability are expressed in percentages by volume, and refer to the downward propagation of flame.

ONE OF THE WAR GASES

One of the most troublesome of the war "gases," merely a scientific curiosity before the war, but in recent months a formidable weapon, is chloropicrin, which Stenhouse first prepared in 1848 by the distillation of picric acid with chloride of lime. From its effect in producing nausea and vomiting, it is known as "vomiting gas." It is very stable, being only slightly soluble in water, and is not decomposed by most of the active chemical reagents.

It requires a comparatively high temperature to change it from the usual liquid form into a gas, and it is generally used in gaseous mixtures in artillery shells or bombs. Through its vomiting effect, a slight whiff of it forces the removal of the protective mask. Being so inert chemically masks can absorb it only by the mechanical action of charcoal, yet, though so inert, it is a powerful poison, causes blindness when highly concentrated, is an active lachrymator even when much diluted, and in contact with the skin produces painful and slow-healing burns and deep abscesses. It has been used to some extent in cloud attacks with chlorine. It is effective in delaying the occupation of any ground, as its high boiling point causes it to be long retained in the soil, while it is sufficiently volatile to keep the overlying air stratum thoroughly poisoned. Recently discovered insecticide value promises the material a future in peaceful agriculture.

AUTOMOBILE AIR RESISTANCE

In speaking of air resistance to a moving automobile, an expert first takes up the resistance of the windshield. The air current, he says, strikes squarely on the flat surface and leaves a vacuum behind for a certain distance. Various eddies and back draughts are caused. On a roadster these are extremely unpleasant for the driver, and in a touring car the rear passengers suffer. A sloping windshield helps to deflect the air current in a better way and also decreases the head-on resistance.

The resistance which the car has to overcome is the resistance due to the speed of the car itself plus or minus the speed of the wind, according to whether it is a head or tail wind. For the sake of simplicity a direct wind will be taken so that complicated figures can be avoided by ignoring the side winds. In order to determine the car's resistance to the air, the area of the surfaces that are presented must be determined.

The parts to be considered are the radiator, radiator mudpan, windshield, fenders, front and rear; maximum width of the body, and the headlights.

If tool or battery boxes and spare tires are carried on the side of the car or running board, they must also be taken into account. Not only do they offer additional resistance surfaces to the air, but they tend to break up the air streams, forming various broken and cross-currents.

In order to obtain an accurate idea of the power absorbed by the air resistance, an area of 25 square feet is taken by the expert as the frontal surface affected by wind resistance, as this is a good average for an ordinary car. The formula for getting the wind resistance will be taken where P equals $0.003\ AV.^2$ A is the area in square feet, V is the velocity in miles per hour, and P the pressure in pounds. This will give, for the speed of 10 miles per hour, 7.5 pounds; for 20 miles an hour, 30 pounds; for 30 miles per hour, 67.5 pounds.

The next thing to do is to find out how much power is used. This can be determined by the formula:

$$\frac{P \times \text{ft. per min.}}{33000}$$

Working out with the three pressures obtained above the horsepowers required are 2, 8 and 18 respectively. It will be noticed that the horsepower required increases rapidly with the speed, and if a speed of 60 miles an hour be taken the pressure becomes 270 pounds and the horsepower required 72.

The last condition could occur if the car were running at 30 miles per hour against a wind going at 30 miles per hour. This would result in the same wind pressure that would be had by driving at 60 miles per hour without a head wind, but in this latter case the engine would be running at only half the speed and consequently would be developing only half the power.

WHERE TO PUT THE AIR COMPRESSOR ON THE LOCOMOTIVE

The question of mounting on the locomotive boiler the various accessories necessary to the supplementary functions of the locomotive power plant has become particularly acute as it concerns the air compressor. Boiler dimensions have become such as to crowd this important adjunct off the side of the boiler and onto the front end, where certainly, however resourceful the constructor who conceived and executed the idea may be considered to be, the compressor is at a serious disadvantage. Lubricating difficulties are but one of the several phases of the matter that discredit this location. Conditions have arisen lately which have prompted regional directors to caution

their mechanical forces against so locating compressors as to obstruct the vision of the fireman or others having occasion to view the track from the fireman's side of the cab. Where to put the compressor seems to be developing into quite a puzzle.

We once ventured to suggest the placing of the compressor in a horizontal position, say underneath the running board or even on the under side of the boiler, in case the design happens to permit. Objection is raised, of course, as though the idea of a horizontal engine, pump or compressor is too radical to permit of any such innovation. Precedent is a great stabilizer, to say the least. If it be essential that the compressor be maintained in an upright position, how would some venturesome designer like to figure out an installation on the forward end of the tender? Are our flexible metallic connections equal to the occasion? A compartment, closed or otherwise, could easily be arranged, permitting ready access for attention while running, and there would be presented the attractive opportunity of providing a water jacket for the air end or possibly a water submerged radiating coil, which would be a quick solution to certain condensation difficulties that some roads now experience. The main air reservoir should find as acceptable a mounting on the tender as it does on the locomotive. Air pump exhaust under some conditions, is an enormous waster of fuel when piped into the exhaust passage or otherwise permitted to escape through the stack. The experiment has been tried of utilizing this steam to pre-heat the water in the tank. With the compressor already mounted on the tender this problem, too, if worthy of solution at all, would be very much simplified.—*Railway Review.*

TRAPSHOOTING AND LEAD MINING

Every trapshooting club is an embryo lead mine, needing only to be worked to return a rich profit, says the *Du Pont Magazine* for February. After three years of shooting over the traps of the Du Pont Club, Wilmington, Del., the grounds were mined and 23 tons of lead was recovered. The grounds at a Columbus, Ohio, gun club were mined several years ago. Twenty-six tons of lead were salvaged, one pound of shot being extracted from 60 lb. of dirt. The Elliott Shooting Park, at Kansas City, Mo., owned by Robert S. Elliott, the pioneer gun-club miner, yielded a quantity of lead worth $850 the first year it was mined. Two systems are used in recovering shot from the ground—the blower and the placer.

The blower system is the simplest and the easiest to install. This method was used on the Du Pont grounds. The surface where the greatest amount of shot fell was scraped, one inch of sod and soil being removed to a shredding machine, where it was chopped up finely. A blower was attached to this machine, which was just strong enough to blow the soil out through a pipe. The shot, being heavier, fell into a trough and ran into sacks. The shot was reasonably clean and readily sold. The entire equipment was inexpensive, consisting of the shredder and the blower and a small gasoline engine to operate them. A force of four men kept the machine constantly supplied with dirt. The placer system is more complicated and more expensive to install, and a large supply of water is needed for its successful operation.

PRACTICAL AIRPLANING

Speaking of Vice President Moody of the Prairie Oil & Gas Co., there is one thing which must be told on him, if for nothing else simply because he so dislikes to see his name in print. He actually scouted the Duke-Knowles pool from Ranger in an airplane. The mud was two feet deep in places, deeper in others, and Mr. Moody and Mr. Sankey, of Skelly & Sankey, wanted to see what was really the status of the Comanche county wells. An aeroplane pilot offered his services. The machine would not carry three, so Mr. Moody made the 21-mile trip first, picking out the well from 5,000 ft. in the air and directing the pilot where to land. The airplane then returned to Ranger, got Mr. Sankey, and brought him down. Both gentlemen returned in the same conveyance.—*Oil Trade Journal.*

In order to stimulate French industries, preparations are being made by France to revive the ancient prestige of her great fair known as the Fair of Lyon, and manufacturers of the Allies and the neutral countries have been invited to display their wares.

There was an average daily delivery of 1026 cars of export material at the port of New York during October.

COMPRESSED AIR MAGAZINE

EVERYTHING PNEUMATIC

Established 1896

W. L. SAUNDERS, - - - Editor
FRANK RICHARDS, - Managing Editor
CHAS. A. HIRSCHBERG, - Business Manager
W. C. LAROS, - - Circulation Manager

PUBLISHED MONTHLY BY THE

Compressed Air Magazine Company

Easton, Pa.

New York Office—11 Broadway.
London Office—165 Queen Victoria Street.

Subscription, including postage, United States and Mexico, $1.00 a year. Canada and abroad, $1.50 a year. Single copies, 10 cents.
Those who fail to receive papers promptly will please notify us at once.
Advertising rates furnished on application.

We invite correspondence from engineers, contractors, inventors and others interested in compressed air.

Vol. XXIV. March, 1919. No. 3

CONTENTS

Contractor's Compressed Air Plant..... 9059
Tamping "Plums" With Jackhamers.... 9063
The Titan Pneumatic Hammer..... 9064
Three Stage Compression of Cotton.... 9064
Large Turbo Blowers..... 9065
Reversing Mine Ventilation..... 9066
Strainer for Air Brake Pumps..... 9067
Reversed Heads in Pressure Vessels.... 9068
Two Turbo Blowers..... 9070
Pneumatic Traveler for Conduits..... 9071
Lubrication of Air Compressors..... 9072
Air Intake Experience..... 9076
Inflammable Liquids and Vapors..... 9077
One of the War Gases..... 9078
Automobile Air Resistance..... 9079
The Compressor on the Locomotive.... 9079
Trapshooting and Lead Mining..... 9080
Practical Airplaning 9080
An Advertising Opportunity..... 9081
The Greater Hudson Tunnel..... 9082
Training Workers for the Shipyards.... 9083
Tunnel Ventilation Phenomenon..... 9086
Where the Workers Work..... 9087
Notes 9087
Patents 9089

AN ADVERTISING OPPORTUNITY

The above title should not fail to attract some attention, for advertising is a recognized business necessity. It is not enough in these days to do honest and competent work in the manufacture of goods, and to produce them in considerable quantities. To keep things going these goods must be sold at a reasonable profit and at a rate commensurate with the speed of production, and this cannot be done unless buyers can be found in sufficient numbers. That they may be found and brought in touch it is necessary that the readiness and fitness and reliability of the goods to be sold shall be generally known, and the one who must sell to make a living is the one to attend to this. The offering of the goods for sale, and the dissemination of the information that they are for sale, with accounts of their specific adaptations, is as much a part of the business of continuous and profitable production as is the accumulation of the raw materials and their successive manipulation and assembling in the shop.

In the olden time business announcements were made by the town crier at the street corners, in the market place, in front of the parish church, the object being to address as many people as possible with the hope that some among them would be interested in some particulars of the information so laboriously disseminated, but we have vastly improved upon those antiquated methods and have added advantages which were unknown before.

All these things can be claimed for the printed periodicals of the day. Several individual publications now number their readers by millions and each entire crowd is more attracted by the announcements in the catchy style in which they are presented than are the casual constituents of the crowds assembled in the streets, with the added advantage that the printed page repeats its appeal every time it greets the eye, while the spoken or shouted word dies with the breath of the speaker.

The literary, the social, the political, the news publications, while they draw the crowds do not sort them out. The specializing technical journal does far better than this, in that the crowd which it assembles is automatically selected and singled out from the general mass. All its readers are interested in and looking for the same things, and they are

specialized still in the same way when the advertisements call their attention, and the advertiser, so that he is in line with the specialties represented, must know that his advertisement is not wasted.

Compressed Air Magazine is a specialist of the specialists. While the specialty which it stands for is of unusual reach and importance in the world's activities it has the entire field to itself. It is the only publication in the world devoted to compressed air and "everything pneumatic," and it has an unusually large number of readers for a publication of its class who have joined themselves to it to be in touch with its specialty. If anyone has "anything pneumatic" of commercial value and which he wishes to put before those most interested in that line as a business proposition, where in this wide world shall he place it if not in *Compressed Air Magazine?*

THE GREATER HUDSON TUNNEL

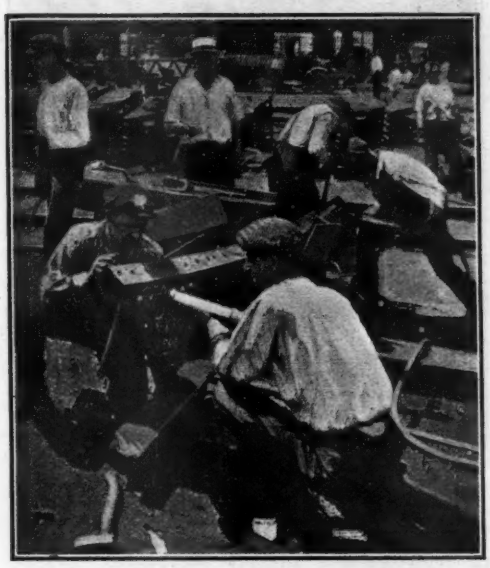
The great engineering works which the growth of the World's Metropolis imperatively demands, each making a new world-record in magnitude of scheme, in the complication of embarrassing conditions involved in the construction, and in the novelty and ingenuity of the devices employed to meet them, follow each other in rapid succession. At the present moment the most imposing undertaking in sight is the building of the great tunnel for vehicular traffic under the Hudson and connecting New York and New Jersey for their mutual benefit.

This is at present spoken of as only a project, but we may be well assured that in a very short time it will be an accomplished fact, and the wonder at once will be as to how the communities benefitted could have so long endured existence without it. Various information concerning the proposed tunnel has already been presented in our pages, showing that everything has been thought out and planned in detail, so that when operations are begun they will be carried forward with a continuous rush. The man who completed the Panama Canal, who is consulting engineer to the Bridge and Tunnel Commission, says that the tunnel can be completed in two years, and he not only knows but has the proved ability to make good his words. The first and determining operation in the case of this tunnel as of every other is the "raising of the wind," and this the financiers and the legislators are already busy at. It is only necessary to have the assurance that twelve millions of dollars will come along as called for, and the public will look upon all the operation of construction as the mere carrying out of the customary routine.

We are specially interested in all tunnel construction, for that is one of the chief and unfailing fields of employment for compressed air. If the tunnel is driven in the solid rock it gives impulse to all the drills and is employed for incidental purposes. In subaqueous tunnels driven in soft material an entirely different application of compressed air is involved. In the big tunnel here spoken of men will have to work under higher pressures then in the tunnels previously driven here, on account of the much larger diameter of the bore which will carry the bottom of it to a considerably greater depth.

When the tunnel is completed and to be put into service another serious air problem arises. This tunnel is to be used by the modern vehicles of the streets and highways, and these whether for pleasure or more numerously for freight light and heavy are now practically all driven by gasoline, the combustion giving off the deadly D O, so that the products of combustion discharged freely into the tunnel must be immediately, continuously and unfailingly removed and replaced by pure air. It is planned to provide blowers and exhausters and systems of ducts which will renew the air content of the entire tunnel every ten minutes, and this arrangement will be by no means too liberal for the purpose when fully active, while if a short stoppage of the circulation should occur a most appalling tragedy might result.

There is thus in this case a special problem which has not before arisen, but which is believed to be fully understood and in competent hands to be taken care of. The valuable and important service which the tunnel can, and doubtless will, render is not to be belittled, and we may well believe that its success will lead to other undertakings as yet but little thought of.



BEGINNING ON THE "FARM"

TRAINING WORKERS FOR THE SHIPYARDS*

By R. V. Rickord

The education and training section of the Emergency Fleet Corporation, known in its embryonic stages as the industrial training department, has been in operation for twelve months. The work of the section consists partly in placing at the disposal of the various shipyards facilities to enable them to do a systematic and thorough job in the training of shipyard mechanics, and partly in conducting other features, such as the distribution of electric welding information and the training of men for the higher marine engineering positions. The policy adopted by the Emergency Fleet Corporation in the matter of trade training has led to the creation of a new trade in the shipyards, namely, that of instructor, and one of the first jobs which presented itself was that of supplying a basis on which to build up this new trade.

When the Emergency Fleet Corporation was quite young, Admiral Bowles foresaw the difficulty connected with the breaking in of new men and the danger lurking in any promiscuous or old-time scheme, such as that in not only taking an unduly long time to make the required mechanics but also in turning them out in "half-baked" condition. While the shipyards were following up the scheme of breaking in men by placing them on the vessels as helpers, the study of how most efficiently to teach men trades had been going on for years by various interested authorities in institutional, municipal and university undertakings. It was from men of this type that Admiral Bowles sought advice and help. The result was the creation of a staff of expert trade teachers, each one of whom was an expert tradesman as well as an expert teacher, and whose job it was to convert an expert shipyard tradesman into a man of his own type, so that the tradesman could break in new men with a thorough working knowledge of the trade in the shortest possible space of time.

A definite scheme of study for prospective instructors was hit upon. Each instructor has had to go through the "dope," as the shipyard men popularly call it. No one has been certified as being qualified for the work of instructor unless he has satisfied the Emergency Fleet Corporation that he can handle a group of green men and instruct them properly.

After a year's efforts a large proportion of shipbuilders all over the country have, with

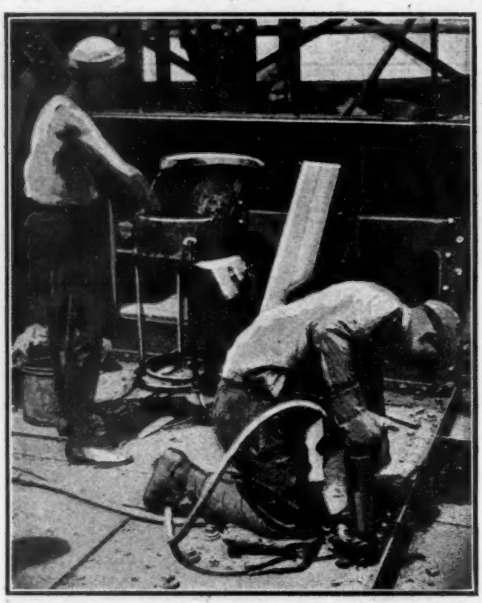
WORKING UP ALOFT

*Abstract from *International Marine Engineering.*

the co-operation of the Emergency Fleet Corporation, installed Training Departments, and in District No. 2, with which this article mostly deals, almost 100 per cent. have recognized the superiority of the new method by installing the training departments recommended by the corporation. The figures showing the number of instructors trained and in training by the Emergency Fleet Corporation for the various steel yards in the district are as follows: Bayles, 9; Downey, 30; Federal, 22; Newburgh, 20; Standard, 10; Staten Island, 9; Submarine, 120.

No difficulty has been experienced in holding the tradesman's interest in the new undertaking. It may, indeed, be said that his efforts along instructional lines are quite extraordinary. He is called upon to make very extensive efforts during his six weeks' training period in learning how best to teach his trade, and this has the effect of so arranging the various details and aspects of the trade in his mind that the yard training department has frequently found itself face to face with the fact that no sooner has he been trained as an instructor than he has immediately been pressed into service as a foreman.

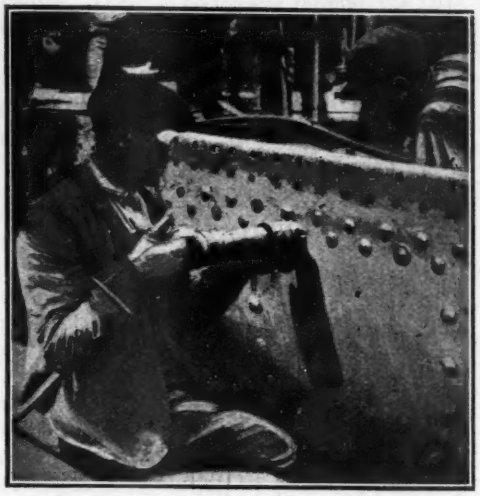
As soon as the embryo instructor begins to analyze his trade for instructional purposes, he sees it in an altogether new light and the new purpose becomes magnified. He picks out a series of representative jobs and gives these to the learner, being sure that the learner has thoroughly learned one representative job in the trade before proceeding to the next. In other words, a smoothness of progression is obtained by starting the learner with the easiest job and proceeding gradually with the harder jobs until the most difficult job that he can be expected to do is given him.



FLUSH RIVETING ON A DECK

FLUSH RIVETING ON SHELL

The riveting jobs shown in the illustrations serve to explain this. Beginning with Fig. 1, the learner is shown doing the easiest kind of snap-head riveting on the "farm;" then the same kind of work on a vessel in an easy position; then doing a somewhat more difficult job—flush-riveting on the deck of a vessel—and after this higher and more difficult positions, until, later, the more exacting flush-riveting work, and finally doing what is probably the most particular work on the ship that can be expected of him, namely, flush-riveting on the shell of the vessel. The instructor is with the learner most of the time and follows him through all these jobs while in training, and in doing this can break in from four to ten new men at a time. All the work of training is done on the vessels or in the shops, so that every effort counts towards the completion of the ship, although the pri-



A FINISHING JOB

mary object of the instructor is not to produce ships but to produce new tradesmen.

The remarkable records accomplished by men who have come from the training departments of the various shipyards only one to three months previously are probably due to the thoroughness with which all of the steps in the trade are taught. The most difficult job a man can do is comprised of the many minor jobs he has done previously, so that having learned the previous jobs thoroughly he finds no difficulty in doing the many small jobs which make up the big one.

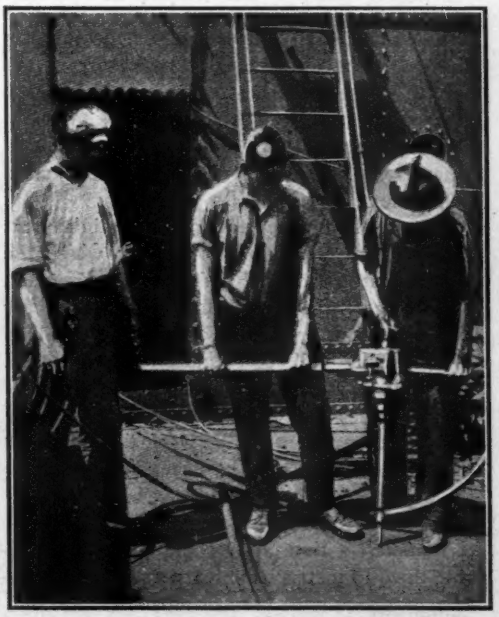
The riveting records of a few men from one yard taken at random will be of interest. The trades given are the former trades of the men, and the records are those per day of ten hours. The yard had a riveting average of about 300 rivets per gang per day, and the men's records, after the men had been transferred from the training department to the production department not longer than three months previously, were as follows:

RECORDS OF WORKMEN

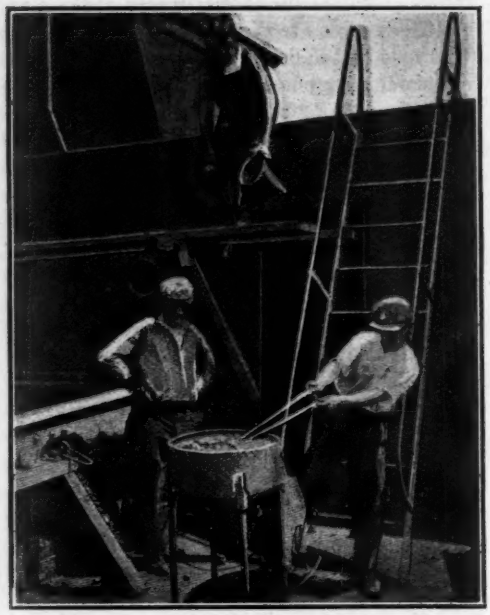
Previous Occupation.	Number of Rivets.	Flush Rivet Sizes.
Auto mechanic	440	7/8
Rock driller	1,808	3/4
Cowpuncher	900	3/4
Laborer	720	3/4
Policeman	640	3/4
Broker	650	3/4
Holder-on	850	3/4
Helper	950	3/4

The reorganization of a training department is such that one individual is responsible for all the training that is done in the yards. The job of this man is really that of "foreman of training," and he is responsible for the making of tradesmen out of "green" material. He works and co-operates with the various fore-

CALKING



REAMING



HEATING AND THAWING RIVETS

men in the yard, but not under them. He obtains from them all the work to be given to the men in training, and is responsible for the correctness and quality of the work. The separation of the training work from the ship work as ordinarily supervised by the foremen is due to the difference in the nature of the job. The men who do the training must have the opportunity to do their work without scampering through it, which is very difficult when done under pressure of the production department.

The ideal arrangement in the establishment of a training department is one in which the department "heads up" under a superintendent or manager who has sufficient sympathy for the movement, or desire for a proper trial, to bring about full co-operation between the training department and the production departments. This type of man obtains for the training department all the work the ships and in the shops that may be necessary to enable the department to fully instruct all the learners it has on hand. Also he will give instructors sufficient time and encouragement to enable them to instruct the learners properly and in accordance with the arrangements laid out, and in which they have been introduced, by the Emergency Fleet Corporation. The placing of the training department under the proper individual superintendent or manager in the yard, in order that the proper co-operation and encouragement is obtained, probably has more to do with the successful working of a training department than any other item.

A TUNNEL VENTILATION PHENOMENON

In *Heating and Ventilating Magazine* attention is called to the peculiar complication of conditions affecting the temperature and the humidity of the air in the Chicago freight tunnel. The great masses of materials of various characteristics through which the tunnel is driven act as a constant reservoir of heat, extracting heat from the tunnel air when the latter is warmer than the tunnel surface. During cold weather the opposite flow of heat takes place, the heat stored in the materials about the tunnel being given back to the air through the millions of square feet of tunnel surface. These conditions balance so accurately that the entire temperature variation throughout the year in the tunnel air is less than 10 deg.

This has had a rather unusual result. In the summer months air is almost always in a saturated condition as the outside air is cooled to the dewpoint. This keeps the tunnel air practically free from dust, partly because the condensation of moisture on the dust particles causes their precipitation to the tunnel invert.

In the summer of 1916 a complaint was received respecting the use of tunnel air in a cold-meat storage room of a certain downtown hotel, the claim being made that such air is unsanitary. Various tests for air purity were made and revealed a remarkable freedom of the air from dust.

SATISFACTORY SAND CAR RECORDS

Sand cars, in which the sand is transported in a steel tank whih can be put under air pressure for the purpose of forcing the sand out through a hose or spout close to the track, have been described in recent issues of *Compressed Air Magazine*. Cars of this type have been in use long enough to demonstrate their entire reliability. For example, the Philadelphia Rapid Transit Company put a couple of cars in service early in 1913, and they have operated with entire satisfaction and have not introduced any particular maintenance diffi-

culties. There is no trouble through the clogging of sand in the discharge pipe if the sand is perfectly dry. The ease with which sand can be forced out through a pipe under air pressure is surprising, but a glance at an hour-glass in action will readily convince anyone of the "fluidity" of perfectly dry sand. It is certainly a great convenience to utilize this quality in distributing dry sand to carhouses for redistribution to the cars.

When first put into service the Philadelphia cars had but one source of air which had to provide for braking and also for discharging the sand. This proved to be unsatisfactory in that the cars reached the carhouses without full air pressure on the tank, and some time was lost in the pumping-up process. Now separate compressors are used for the two functions, with saving of time and lessening of compressor maintenance.

WHERE THE WORKERS WORK

The factory law passed in Japan in 1911 was not promulgated until September 1, 1916. Under this law the employment of boys under 15 years of age and of girls and women for more than 12 hours a day was prohibited, but it was provided that in the textile industries the working hours might be extended up to 14 hours during the two years following the promulgation of the law. In view of the expiration on September 1 last of this limit of two years, the employers concerned had addressed a memorial to the Government early in the year asking for a revision of the law, so that the working hours for small boys and female operatives could be extended up to 14 hours for the next three years, and to 13 hours during the ten years following, but the authorities had rejected the memorial. The factory owners, however, intended to ask again the Government to postpone the curtailment of the working hours.

VACUUM CLEANERS FOR RAILROAD WORK

Vacuum cleaners are used by the Cleveland (Ohio) Railway Co. to clean car interiors prior to painting and varnishing and to remove dirt from motor frames prior to overhauling. A stationary turbine cleaner serves suction headers from which depend drop lines reaching to within 7 ft. of the floor; a minimum length of flexible hosing thence serves any part of the car shop. When it is required to clean motors, the latter are placed over a floor-grating (through which suction is maintained), and covered by a canvas hood. Dust, etc., is loosened by an air-blast and removed by suction; heavy particles are retained by the cleaner and dust is washed into a settling basin under the shop door by a water spray in the eliminator. The equipment is designed to facilitate access to awkward places and its use permits work to be done more thoroughly.

NOTES

Our own navy has now a flying boat which carries 50 passengers with ease. Its wing spread, is 126 ft., length 70 ft. height 25 ft. It is a biplane, with wings 12 ft. from front to rear and is drawn forward by three 12-cylinder Liberty engines driving 4-bladed screws. The fuel carried is 300 gal., which, with armament and military equipment, will serve for 40 to 50 hours' flight.

The Texas Company, South Texas division in order to protect its field men in fighting gas wells, has bought 25 gas masks from the United States Government. The masks were bought at an auction sale at Camp Logan at Houston, and were manufactured for service in France.

In a number of wells in the past in the Gulf Coast section poison gas has been produced and several men have lost their lives in fighting these gas wells. With the protection of gas masks much of the danger will be eliminated.

That white may be twenty-three different colors is one of the surprising things learned recently. The Textile Color Card Association of the United States called for sample shades and found that twenty-three of the largest color users in the country had exactly twenty-three opinions as to the proper shade for white.

The member societies of the Engineering Council are now the American Society of Civil Engineers, the American Institute of Mining Engineers, the American Society of Mechani-

cal Engineers, the American Institute of Electrical Engineers, the American Society for Testing Materials and the United Engineering Society.

A well-known motor car was designed by running the weakest parts to destruction and then increasing the factor of safety until the required length of service was obtained. The information that the manufacturer obtained by this method was costly at first, but that car has obtained a reputation for durability that has not been equaled.

The consolidation of the Niagara Falls Power Co., the Cliff Electrical Distributing Co. and the Hydraulic Power Co. of Niagara Falls, N. Y., into a new corporation under the name of the Niagara Falls Power Co. has created the largest electric power company in the world as regards energy output. Approximately 2,000,000,000 kilowatt-hours will be generated yearly in the hydro-electric plants of the company. The company, including the plant of its subsidiary, the Canadian Niagara Power Co., has an installed capacity of 370,000 horsepower and is installing an additional 100,000.

Natural gas carries with it the vapors of gasoline and other hydrocarbons that may be recovered in liquid form by the absorption process. Briefly, this process consists in spraying an absorbing oil downward through a tower and forcing the natural gas upward through the spray. The oil absorbs the gasoline from the gas, which passes out and can be used for fuel. The gasoline is then driven off from the absorbing oil by steam heating and the vapors are condensed, producing liquid gasoline. The absorbing oil, freed of the gasoline, is cleaned and used again as an absorber.

Well-organized shifts and bonus payments were largely responsible for the unusual speed of nearly 200 ft. a month for five months in sinking a 11x21-ft. rock shaft for the Seneca Mining Co., at Mohawk, Mich. A flat rate per day was paid up to the first 100 ft. per month; 2c. per foot per day bonus was paid for all over 100 ft. up to 150 ft.; 3c. per foot per day for all over 150 up to 200 ft. and 4c. per foot per day for all over 200 ft. per month. A total of 994 ft. of shaft was sunk in 129 working days in five months from May to September, or an average of 7.7 ft. per day.

An electric motor of extremely small dimensions has appeared on the market in Germany. The motor is enclosed in a shell of 3 cm. (1.18 in.) diameter and 4 cm. (1.57 in.) long. The shaft is arranged so as to hold tools that are required by dentists and surgeons, but the device should be of great use for other purposes, such as boring small holes in metals and rare stones. The motor can be driven by direct or alternating current, and runs at a maximum speed of 5,000 r.p.m.

In the construction of a 537-ft. by 160-ft. extension to the Vancouver, B. C., pier of the Canadian Pacific Ry., boring and drift-bolting was done by air tools, the air being furnished by a motor-driven air-compressor outfit. Pipe lines were laid from the compressor and connections tapped in with hose leading to air riveters with special sets for drift bolting and to boring machines. The borers proved particularly useful in putting down the 2-in. by 4-in. Australian hardwood flooring, which had to be bored for nailing. For this flooring alone 70,000 holes were required.

A new heat-insulating material is being produced in Sweden which is stated to be very promising. The chief material is a kind of clay, "molera," which is very porous, each grain appearing to be hollow. This fact is no doubt largely responsible for its great heat-insulating properties. After it has been burnt the molera becomes extremely light. Before it is burnt it is mixed with cork. The new insulator is said to be primarily suitable for lagging steam pipes and boilers, but may also have uses for the production of sound-proof chambers, and as a medium to check the transmission of vibration.

The great scarcity of wool in Germany has rendered increasingly difficult the manufacture of air-filters using pockets of woollen material. As air filters are essential in connection with the cooling of electric machines and the operation of compressors and the like, it has been necessary to devise new types of fil-

ters not using wool. A firm has developed a filter constructed completely of iron. The abstraction of particles from the air is effected by passing it through iron filtering surfaces that offer a large surface to the current of air, and impose frequent changes in its velocity and direction. The filter differs from other filters without wool in requiring no water or oil, the process being carried out dry.

On the average the original plant substance from which coal was formed contained about 40 per cent. of oxygen and a comparatively low percentage of carbon. As the process of the formation of coal went on the oxygen was gradually decreased and the proportion of the carbon thereby increased. Anthracite coal contains only about 2.5 per cent. of oxygen and a very high percentage of carbon. With the progress of carbonization, the percentage of the volatile matter also decreases and its quality undergoes a change which makes it easier to burn. Thus, although the oxygen content itself may not directly affect the combustion qualities of a coal it may be regarded in a way as an indicator of such qualities.—*Bureau of Mines Bulletin No. 135.*

Mr. G. D. E. Mortimer, a mining engineer, of Point Loma, California, claims to have the highest telephone system in the world, the installation being at an altitude of 15,500 ft. above the sea level. This telephone system is situated at Sonata Bolivia, South America, where the installation of a telephone system for the Inca-oro Mines Company between the various parts of the mine and the town of Yani has just been completed. The total length of the line is 10½ miles, all of the installation being at an altitude of 15,500 ft. Deep snows, snow slides and ice have to be contended with at the mines of the Inca-oro Company, while in the valleys of Bolivia the swollen rivers, terrific heat and the insects of the tropics are equally unpleasant.

The smaller clearances of structures in France, as compared with those in the United States, had contributed, up to some weeks ago, to 127 American soldiers being killed when riding on the tops and sides of cars in France. Three notices were issued to the troops warning them of the danger owing to there being only six inches clearance. One such said: "Three Kinds of Fools. (1) Fools. (2) Damned Fools. (3) Soldiers who ride on tops and sides of cars. A great many American soldiers have already been killed as a result of riding on top of cars. There is only six inches clearance between tops and sides of cars and bridge superstructures. There is only a slight clearance between sides of cars and signal towers. If you expect to see the next block keep yours inside."

The Engineering Societies Employment Bureau, New York City, desires that state and municipal authorities, corporations and individuals who need the services of professional engineers communicate their wants to the Bureau, 33 West Thirty-ninth street. This bureau is maintained by the four national Societies of Civil, Mining, Mechanical and Electrical Engineers. In behalf of engineers who have been serving in the army or in government capacities during the war, it is the desire of the Engineering Societies to get in touch with contemplated engineering projects as early as practicable. By resolutions adopted unanimously (by the 650 members present at its annual meeting) the American Society of Civil Engineers has recorded "its profound conviction that public works should be carried forward to the fullest extent consistent with sound judgment, not only for fundamental economic reasons, but for humanitarian reasons."

LATEST U. S. PATENTS

Full specifications and drawings of any patent may be obtained by sending five cents (not stamps) to the Commissioner of Patents, Washington, D. C.

DECEMBER 3.

1,286,250. AIR-CLEANER. William H. L. Donaldson, St. Paul, Minn.

1,286,302. TRACK-SANDER. John H. Hanlon, Somerville, and William J. Hanlon, Fitchburg, Mass.

1,286,307. ELASTIC WHEEL. Schuyler C. Hatfield, Baltimore, Md.

1,286,319. COTTON-GIN OR LINTING-MACHINE. Wesley A. J. Hodo, Cleburne, Tex.

1,286,359. AIR-GUN. Charles F. Lefever, Plymouth, Mich.

1,286,571. VACUUM-CLEANER. Alva J. Fisher, Evanston, Ill.

1,286,582. AIR AND GAS MIXER. Frank W. Gault, Jr., Okolona, Ky.

1,286,687. FORGING-PRESS. Eugene L. McGary, Chicago, Ill.

1,286,841-2-3. ELECTROPNEUMATIC BRAKE. Walter V. Turner, Wilkinsburg, Pa.

DECEMBER 10.

1,286,939. PNEUMATIC STRAW-STACKER. John V. Carter, Indianapolis, Ind.
1,286,951. AIR-STRAINER. David P. Davies, Racine, Wis.
1,286,992. PNEUMATIC TOOL-DRIVING DEVICE. Andrew A. Gewont, Detroit, Mich.
1,287,007. AIR-BRAKE-EXHAUST. REDUCER. John O. Harrison, Boone, Iowa.
1,287,046. FLUID-DRAWING SIPHON FOR BOTTLES. Fred E. Knapp, San Diego, Cal.
1,287,060. AIR-CIRCULATING DEVICE. Willard M. McEwen, Chicago, Ill.
1,287,142. AUTOMATIC PNEUMATIC CARD-ASSORTING MACHINE. Arthur S. Trew, Portland, Oreg.
1,287,169. VACUUM-PRODUCING SYSTEM. Howard A. Young, Chicago, Ill.
1,287,325. PNEUMATIC STARTER FOR ENGINES. Anton Huwiler, Basel, and Harry Maggi, Zurich, Switzerland.
1,287,367. CENTRIFUGAL COMPRESSOR. Louis C. Loewenstein, Lynn, Mass.
1,287,433. PNEUMATIC COTTON-PICKER. Will H. Radford, Kenedy, Tex.
1,287,557. AIR-BRAKE MECHANISM. John B. Wright and Frans O. Lawson, Greensboro, N. C.

DECEMBER 17.

1,287,630. COMBINED ATMOSPHERIC COOLING AND CONDENSING TOWER. Edwin Burhorn, Hoboken, N. J.
1,287,751. VALVE AND VALVE-GRID SUPPORT FOR AIR-COMPRESSORS. George M. Richards, Philadelphia, Pa.
1,287,780. POP-GUN. Ora A. Stanard, St. Joseph, Mich.
1,287,800. AUTOMATIC FIRE-EXTINGUISHING APPARATUS. Everett L. Thompson, Dover, N. J.
1,288,097. AIR-VALVE AND METHOD OF MAKING SAME. Claud V. Martin, Norwalk, Ohio.
1,288,104. AIR-HEATER. Thomas C. Maxfield, New York, N. Y.
1,288,266. METHOD OF SUPPLYING FUEL TO INTERNAL-COMBUSTION ENGINES, &c. Charles L. Stokes, Los Angeles, Cal.
1,288,312. VACUUM-CLEANER. Joseph Wagner, Cleveland, Ohio.
1,288,370. PRESSURE-GAGE. Ralph W. Zimmerman, Chicago, Ill.
1,288,393. AIR-FILTER. Vito Di Sante, Wichita, Kans.
1,288,420. VACUUM FUEL-FEED DEVICE. Webb Jay, Chicago, Ill.
1,288,435. FLUID-PRESSURE CUSHIONING, DEVICE. George Manierre, Milwaukee, Wis.
1,288,438. METHOD OF AND APPARATUS FOR DRYING AND COOLING GRAIN. Fulton R. Morris, Milwaukee, Wis.; Cassius E. Morris and Mark R. Morris, executors of the will of said Fulton R. Morris, deceased.
1,288,445-6-7. PNEUMATIC SEAT. Henry Seibel, Los Angeles, Cal.

DECEMBER 24.

1,288,496. CLAY-GUN. Edgar E. Brosius, Pittsburgh, Pa.
1,288,705. COMBINED VACUUM-CLEANER AND SWEEPER. John W. Shanahan and Francis C. Mason, Grand Rapids, Mich.
1,288,728. ROTARY BLOWER. Ira H. Spencer, West Hartford, Conn.
1,288,821. AIR SAFETY-VALVE. Thomas William Broderick, Salamanca, N. Y.
1,288,850. OXYGEN-INHALING DEVICE. Harvey E. Easly, Waterloo, Iowa.
1,288,856. RESPIRATOR. Lewis Farr, El Portal, Cal.
1,288,860. COMBINED HYDROAEROPLANE AND SUBMERGIBLE CRAFT. Polomede Ferrari and Enrico Mollioli, East Berlin, Conn.
1,288,879. BLOWPIPE FOR WELDING-MACHINES. John Harris, Lakewood, Ohio.
1,288,887. VAPOR-VACUUM-CONTROLLER VALVE. Harry Hall Hess, Philadelphia, Pa.
1,288,891. SHOCK-ABSORBER. Reuben F. Hoffman, Hamilton, Ohio.
1,288,937. LANDING-GEAR FOR AIRSHIPS. Frederick H. Leinweber, Chicago, Ill.; Curtis H. Leinweber, William H. Leinweber, and Victor H. Leinweber, executors of said Frederick H. Leinweber, deceased.

1. The combination with an airship body, of a plurality of compressed fluid cylinders in said body and extending downwardly with relation thereto; a piston cylinder operating in each of said cylinders; a piston operating in each of said piston cylinders; a piston rod for each of said pistons; a traction wheel on each of said piston rods; and means for supplying said cylinder and piston cylinder with fluid under pressure and exhausting the same, substantially as described.

1,288,965. ROD-BENDING MACHINE. Clyde Alston Nelson, Cristobal, Canal Zone.
1,288,966. TIRE-PUMP. Thomas H. Nielsen, Wyoming, Del.
1,289,039-40. MEANS FOR CONTROLLING PNEUMATIC ANTIVIBRATION DEVICES FOR AUTOMOBILES. George William Bell, Liverpool, England.
1,289,042. BLOW-TORCH. Robert E. Campbell, Berkeley, Cal.

DECEMBER 31.

1,289,082. AIR-CUSHIONING DEVICE. Anson M. Bangs, South Bethlehem, Pa.
1,289,132. PNEUMATIC SHOCK-ABSORBER. Warren S. Eaton, Plainfield, N. J.
1,289,144. PULVERIZED-FUEL BURNER. Harry S. Flanegin, Pottsville, Pa.
1,289,285. VALVE FOR PERCUSSIVE TOOLS. Fred M. Slater, Easton, Pa.
1,289,364. METHOD AND APPARATUS FOR COOLING BEER. Thomas R. Beggs, New York, N. Y.

1. The method whereby beer may be drawn without undue foaming from kegs maintained at atmospheric temperature, which consists in subjecting the beer in the keg to a pressure sufficient to maintain carbonic acid gas in the absorbed state in the beer, cooling the beer after leaving the keg with the stated pressure maintained and reducing the pressure on the beer while still cool and immediately prior to its escape to the atmosphere.

1,289,383. GAS AND AIR MIXER FOR GAS-BURNERS. William C. Buell, Jr., Sewickley, Pa.
1,289,391. CONTROL DEVICE FOR PENUMATICS. Frank Carnahan, South Boston, Mass.
1,289,451. AIR-GAGE. Martin A. Hougen, Minneapolis, Minn.
1,289,543. DIRECT AIR DISPLACEMESNT-PUMP. John Rigling, Philadelphia, Pa.
1,289,546. AIR-HEATER FOR LOCOMOTIVES. Carl Rochelle, Raleigh, N. C.
1,289,672. METHOD OF PRODUCING AND MAINTAINING VACUUMS. William D. Coolidge, Schenectady, N. Y.
1,289,728. PNEUMATIC VEHICLE-SPRING. Herbert H. Giles, Brooklyn, N. Y.
1,289,755. AUTOMATIC WATER-DEPTH INDICATOR. Elbert J. Haynes, Detroit, Mich.
1,289,757. AUTOMATIC TRAIN-CONTROL DEVICE. Isaac W. Hedges, Quincy, Ohio.
1,289,790. VACUUM FEEDING DEVICE. Jacob Jacobsen, San Francisco, Cal.
1,289,795. JACK. Henry Johnson, Detroit, Mich.
1,289,845-6. PNEUMATIC ORE-SEPARATOR. Marion S. MacCarthy, Denver, Colo., and Charles F. MacCarthy, Carthage, N. Mex.
1,289,847. FLUID-PRESSURE BRAKE. George Macloskie, Erie, Pa.
1,289,923. FLUID-PRESSURE-ENGINE INDICATING APPARATUS AND THE LIKE. Arthur Ryder, Hartford, Northwich, England.
1,289,986. VACUUM-PUMP AND CONTROL UNIT FOR PLAYER-PIANO MECHANISMS. Charles E. Wenz, Clifton, N. J.